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EXPLANATORY NOTES

FOR

DEPARTMENT OF AGRICULTURE

BUDGET ESTIMATES

FISCAL YEAR

1942

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(Volume 2)

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BUREAU OF ANIMAL INDUSTRY

(a) GENERAL ADMINISTRATIVE EXPENSES

Appropriation Act, 1941	$170,120
Transferred 1941, pursuant to Reorganization Plan No. IV, to the Post Office Department	- 100
Total available, 1941	170,020
Budget estimate, 1942	170,020

PROJECT STATEMENT

Project	1940	1941 (estimated)	1942 (estimated)
General administration and business service	$169,412	$170,020	$170,020
Unobligated balance	708	- -	- -
Total appropriation	170,120	170,020	170,020

WORK UNDER THIS APPROPRIATION

Under this appropriation the general administrative work of the Bureau is conducted. The Bureau is primarily concerned with the protection and development of the livestock industry and animal food resources of the United States. It conducts scientific investigations of the causes, prevention, and treatment of livestock diseases, some of which are transmissible to man; investigates the prevalence of livestock diseases and aids in their control or eradication, often directing extensive field activities; carries on investigations and experiments in the breeding, feeding and management of livestock; and administers the Federal Meat Inspection Act, the animal quarantine acts, the 28-Hour Law, the diseased-animal transportation acts, and the Virus-Serum-Toxin Act. For facility and economy of operation, administrative functions common to the entire Bureau, which is composed of 11 operating divisions, are grouped directly in the office of the Chief. These include primarily the determination of general policies and the supervision of all activities such as publications, preparation of press releases, exhibits, motion pictures, and radio programs on the results of Bureau work; the preparation of estimates of expenditure; the selection of employees, and other phases of personnel management; the procurement of supplies and equipment and maintenance of property records; the various phases of fiscal management involved in the expenditure of funds; the maintenance of a library for the use of scientific and technical workers; and the receipt, classification and distribution of incoming mail and dispatch of outgoing mail.

(b) ANIMAL HUSBANDRY

Appropriation Act, 1941.............	$824,380
Budget estimate, 1942...............	824,380

PROJECT STATEMENT

Projects	1940	1941 (estimated)	1942 (estimated)
1. Swine husbandry investigations.............	$151,972	$132,622	$132,622
2. Sheep and goat husbandry investigations....	151,732	145,386	145,386
3. Horse and mule husbandry investigations....	41,569	41,934	41,934
4. Beef cattle husbandry investigations.......	157,003	188,361	188,361
5. Dual-purpose cattle husbandry investigations....................................	69,820	66,259	66,259
6. Poultry husbandry investigations...........	242,893	243,957	243,957
7. Certification of pedigrees of imported registered livestock.........................	5,891	5,861	5,861
Total obligations..................	820,880	824,380	824,380
Transfer from "Eradicating cattle ticks", Bureau of Animal Industry..................	-10,000	- -	- -
Transfer from "Meat Inspection", Bureau of Animal Industry..................	-10,000	- -	- -
Unobligated balance.........................	2,000	- -	- -
Total appropriation................	802,880	824,380	824,380

WORK UNDER THIS APPROPRIATION

General. The work under this appropriation deals with the collection and dissemination of information on livestock problems of regional and national importance involved in the breeding, feeding, and management of domestic farm animals, including poultry. Many of these experiments are conducted in cooperation with other bureaus of the Department, State agricultural experiment stations, farmers, and other agencies. Results are measured in terms of quantity and quality of animals and their products, such as meat, eggs, wool, mohair, and farm power. This appropriation is used for scientific research and experimentation on a wide variety of major problems of the livestock industry. During the fiscal year 1940 there was returned to the miscellaneous receipts fund of the Treasury approximately $57,500 from the sale of animal products which had served their purpose for investigational work. In addition to research work, the work in connection with the administration of the provisions of paragraph 1606 of the Tariff Act of 1930 in regard to the certification of purebred animals imported by citizens of the United States for breeding purposes is carried on under this appropriation.

Objective: To test the merits of different systems of breeding for improving farm livestock, including poultry, in productivity; to develop strains possessing inherent characters which may improve the level of performance of producers' herds; to study the various factors in management that tend to reduce losses and to develop methods that will keep livestock in a healthy growing condition; to determine the fundamental nutritive requirements of livestock and to develop the best methods of using feeds to obtain maximum results; and to determine the effects of breeding, feeding, management, processing, and other factors on the quality of the products.

The Problem: Problems of chief interest to producers today are (1) how to obtain maximum growth and development with the minimum feed consumption and (2) how to utilize to best advantage feeds grown on the farm. Involved are the perfection of existing methods of breeding and the development of new methods; the intrinsic nutritive value of feeds that compose the ration, including the effect of different methods of harvesting, storing, or processing, and the combination of such feeds in proper amounts to furnish the essential dietary elements. Some losses in livestock are unavoidable while others can be reduced and in many cases prevented by good management practices. Meat and poultry products vary greatly in quality, acceptability, and market value, and a relatively small proportion of the quantity consumed is first class production. Many factors are responsible for this situation and there is urgent need for information on such factors. Because of the fact that farm animals are expensive to maintain it is impossible for the industry itself to conduct research investigations required to point the way toward needed methods of improvement.

Significance: Work under this appropriation deals with problems affecting one of the major parts of the Nation's agriculture. The number of livestock on farms and ranches in January 1940 was approximately 58 million hogs, 54 million sheep, 5 million goats, 15 million horses and mules, and 30 million cattle of beef and dual-purpose breeds. About 400 million chickens and 20 million turkeys are kept annually on farms in the United States. The value of livestock on farms in the United States on January 1, 1940, including poultry and products sold during the calendar year 1939, exceeded $5,100,000,000. Generally speaking, returns from hogs amount to approximately 10 percent of the annual cash farm income and in the Corn Belt may account for as much as 25 percent of the annual cash farm income of the region. Sheep were valued at about $310,000,000 in 1939 and the amount of meat and wool produced by them amounts to approximately $300,000,000 annually. Horses and mules are valued at more than 1-1/4 billion and are agriculture's major source of field motive power. Beef and dual-purpose cattle have a farm value of over a billion dollars and utilize a large share of the nation's billion acres of pasture and range. The widespread significance of our poultry research work is indicated by the fact that poultry are raised on more farms of the country than any other commercial farm product, 85 percent of the total number.

Plan and Progress of Work: The work under this appropriation is conducted under the following projects:

Project 1. Swine Husbandry Investigations:

Matings are planned so that litters of similar but varying intensities of inbreeding will be produced by each sire in the same season. A number of

pigs from different litters are subjected to record-of-performance tests to obtain an index of the relative breeding value of the animals within each herd, and the selection of new breeding stock is based on the production records of each mating. Investigations now in progress are also concerned with a study of the effects of crossbreeding swine and the development of strains which have all the desirable characteristics found in the strains originally used in the crosses. First generation hybrids were subsequently backcrossed to one of their parent strains and this procedure is now being followed by alternate backcrosses and inter se matings. The results to date show that strains of hogs possessing the better qualities of their parent strains tend to excel most of the other strains used in these investigations.

Swine feeding investigations are in progress to determine the effect and value of supplementary feeding of protein-rich feeds to pigs during the suckling period. Tests to determine the proper amount of protein in the ration for growing and fattening pigs are being pursued. A beginning has been made in determining the part nutritional deficiencies of the ration may play in the role of disease. The influence of mineral constituents on the rate and economy of gain and general health of hogs is also under investigation. The existing facilities, including physical equipment of feeding barns and laboratories and animals used in breeding investigations, are utilized in studies on the growing and fattening of pigs which are directed at the usefulness of specific feeds in the ration, as they influence the economy of growth, health of the animal, and quality of the pork produced.

New articles of equipment and improved designs for shelters and housing facilities are under continual observation to determine their effect on the general health of animals. Observations are being recorded on the value of the electric pig brooder in reducing losses of young pigs farrowed in the cold winter months, and to determine what effect added heat has on the growth of the pig.

Studies on conformation and yields, proportion of meat to bone, composition, tenderness, flavor, juiciness, and other characteristics of pork and pork products as influenced by variations in production factors and in processing and preparation are also conducted under this project.

Project 2. Sheep and Goat Husbandry Investigations:

Matings are made on the basis of introducing genes for the highest degree of merit obtainable in the respective breeds, for determining by progeny tests the most satisfactory sires, and for inbreeding to develop lines of outstanding merit, with a view to purifying strains for merit in specific characteristics of economic importance, and eventually to build up superior strains by crossbreeding the purified strains whose characteristics will supplement each other for the concentration of a maximum of desired characteristics. Results to date show that such factors as high merit in length of fiber and weight of fleece, plump mutton form, and freedom from wool blindness can be fixed in strains by inbreeding, and that rather high proportions of the inbred offspring are well balanced and useful sheep.

Feeding and grazing records are kept on several hundred sheep and lambs, chiefly by lots and flocks, classified and grouped for specific studies of the feeding value of certain feeds and forages and combinations of them for specific families, strains, breeds, types, and classes of sheep and lambs. To a limited extent, feeding and nutrition tests are also conducted with individual sheep and lambs. Specific tests are so organized as to have only one designed variable in a given test and to hold other factors as constant as possible.

On western ranges the herding method is being compared with running the sheep in fenced enclosures. Under farm conditions, raising sheep on temporary forage crops and hay meadows is compared with raising them on permanent pastures. Various methods of saving young lambs are being studied, as are methods of skinning pelts from Karakul lambs and of preserving the pelts for fur. Tests have also been made of the salt and water requirements of sheep under various conditions and environments that involve various management practices.

Fleeces of wool from several thousand experimental sheep are graded for fineness, character, density and color of fiber, measured for length of staple, weighed when sheared, and analyzed for content of clean wool, grease, dirt, and moisture, to determine the influences of breed, feed, and management factors on quantity and quality of wool. Wool, mohair, and many other animal fibers are analyzed for structure, uniformity of fineness, and properties affecting their value for use of manufacture, and many animal fibers are filed for use in identification to determine the content of fabrics and other fiber goods. Among recent results of the wool studies is the development of two rapid methods of estimating fineness and cross-sectional variability in wool.

Studies on lamb meat involve investigations of tenderness, composition, proportions of parts or cuts, and other characteristics of the carcasses and meat of the animals as influenced by production factors and processing and preparation.

Goat breeding investigations are at present confined to work with milk goats of the Saanen and Toggenburg breeds. In our experimental herd it has been found possible to increase the average yearly milk yield per doe over that of the foundation animals of common American stock. The lactation period of the improved does of this experimental herd has been increased in length over that of common does. Goats are naturally inclined to give birth to their young in the spring of the year and it is difficult to get a large proportion of the does to breed for kidding at other seasons, so that there is a period of relatively large production of milk in spring and summer and a low production in late fall and winter. Research is in progress to locate does that have a tendency to breed out of the regular season, in order to develop strains that may help to spread the effective breeding season to result in the freshening of some of the does in the fall and winter months, thereby averaging a better distribution of the supply of goat's milk throughout the year.

Project 3. Horse and Mule Husbandry Investigations:

In the studies devoted to draft-horse husbandry problems, breeding efforts have been confined principally to matings of animals of Belgian and grade Belgian ancestry, the aim being to produce a working type adaptable to modern conditions and usage. Results of this work indicate a distinct need for expansion of the mating program to include animals of other breeds, particularly crosses of horses of draft and light type, and exploration of other important physiological problems, especially causes of sterility, the storage and processing of semen, artificial insemination, and control of ovulation.

In order to evolve accurate standards for measuring the physical capabilities and limitations of horse stock, studies are in progress with Morgan horses at Middlebury, Vt., in which efforts are being made to determine the correlations between conformation, quality, action, disposition, and style, with ease of breaking, training, and management and general ability to work, particularly the capacity to carry and pull standard loads for normal periods when used under saddle and harness.

The standard, long-time studies dealing with the production, care, and management of Morgan horses which have been effective in improving such stock for saddle purposes are being continued and uniformity of type is being sought through the use of the sire-line system of breeding.

The plan for nutrition investigations consists of (1) carefully controlled studies of nutritional requirements with special reference to the optimum development of bone, muscle, and tendon for satisfactory performance; (2) field studies of the most efficient use to be made under prevailing conditions of feeds available in different localities; and (3) studies of measurement of performance as a measure of the ultimate results of variations in nutrition.

Project 4. Beef Cattle Husbandry Investigations:

Investigations are being conducted to combine and fix the desirable heredity affecting type, gain, efficiency of feed utilization, and carcass quality in beef cattle. The progeny test is being used as a means of measuring inherited efficiency and quality of production so that superior animals may be identified. Research methods for progeny testing have been developed which offer considerable possibilities for cattle improvement if employed.

Experiments involving newly introduced plants and byproduct feeds are under way to determine their nutrient content and their best use under specific environmental conditions for cattle maintenance, growth, fattening, and reproduction. The complicated nature of the problem is evidenced by the fact that the attack on a particular phase has frequently unearthed new and hitherto unsuspected differences in basic feedstuffs. More recently it has been necessary to give attention to the refinement of some of the generally accepted methods of feed analysis in order to further the solution of a major problem. Work has progressed sufficiently to permit recognition of cattle deficient in certain minerals and vitamins, and some methods of correction and control by modifying the diet have been devised and made available

to the public. Methods have been worked out for using supplements to fatten young cattle economically in order to produce a satisfactory grade of beef, or to utilize farm forage and growth more effectively than heretofore which tie in with the national program of soil conservation.

Beef cattle management investigations are being conducted in laboratories and at field stations in different parts of the United States and are correlated with work on other phases of the problem being conducted by State experiment stations. The studies are necessarily extending over a period of years owing to annual and seasonal variations in uncontrollable environmental factors.

Beef and veal studies involve investigations of characteristics of the carcasses and meat of specific types, breeds, strains, and crosses of cattle, and composition, tenderness, proportion of meat to bone, etc., as influenced by other production factors, processing, and preparation.

Project 5. Dual-Purpose Cattle Husbandry Investigations:

It has been necessary to devise measures of beef-producing ability with this type of cattle before a rating on anything but milk-producing ability was possible. With the improvement of these methods it is hoped that it will prove possible to develop cattle possessing a balance between beef and milk qualities that will breed true for this characteristic. Growth studies made with cattle of this type indicate that the dual-purpose cattle tend to be intermediate between the strictly beef and strictly dairy cattle. Preliminary observations on the relationship between conformation and milk production also indicate that although the most desired beef conformation may not be developed in dual-Purpose cattle, yet an acceptable beef type may be attained without too great sacrifice of milking qualities.

Meat studies under this project are essentially the same as those for beef cattle but are conducted on a more limited scale.

Project 6. Poultry Husbandry Investigations:

Our knowledge of the fundamental principles involved in the production of poultry meat and eggs has increased significantly during recent years as a result of research work which has been done by the various State and Federal agencies. Fundamental information has been obtained regarding the breeding, feeding, management, and physiology of reproduction in the chicken and other kinds of poultry. This knowledge, where applied, has resulted in more efficient meat and egg production, and increased information regarding the genetic constitution of the chicken, its nutritional requirements, and its physiological behaviour.

In our work on the development of a small-type turkey which matures early and is unusually well-fleshed, the average weight of the turkeys produced in the experimental flock is now approximately 13 pounds for the males and 8 pounds for the females, as compared to average weights of 18 pounds and 11 pounds, respectively, for the standard Bronze variety.

Data obtained on the advantages of crossbred chicks for broiler production have resulted in the adoption of crossbreeding for the production of 85 percent of the broilers raised in large broiler-producing areas.

Poultry feeding investigations are being directed along two lines, one having as its objective the measurement of all nutritive requirements of poultry, and the other the measurement of the nutritive properties of feeds. This work includes investigations on the protein, mineral, and vitamin requirements of growing chicks and laying hens; the effect of dietary deficiencies on poultry and poultry products; the fattening of poultry; studies on growth, maintenance requirements, metabolism, and digestion; effect of nutrition on reproduction and on the quality of poultry flesh and eggs; and nutritional diseases. From these studies it is already possible to determine with a reasonably high degree of accuracy how much feed of a given kind is required for maintenance and for egg production, the relative value of different protein supplements, and quantities of the vitamins and more common minerals required, thus putting formulation of poultry diets on a more scientific and economical basis. Hitherto unsuspected causes of poor hatchability have been discovered and means of preventing certain nutritional diseases worked out.

At the request of the organized poultry industry, the National Poultry Improvement Plan was placed in operation during the fiscal year 1936. This optional plan was developed by members of the poultry industry primarily for the purpose of improving the production and breeding qualities of chickens and of reducing losses of chicks from pullorum disease. In organizing this program of poultry improvement the Department assumed the obligation of coordinating the work among the participating States, and the official State agency in each of the participating States obligates itself to direct, supervise, and be responsible for flock selection, testing for pullorum disease, and other local administrative work. The Department now has memoranda of agreement with 44 official State agencies in as many States which are cooperating in the administration of the plan. The extent and nature of the participation during the first five years is shown in the following table:

Data Concerning the National Poultry Improvement Plan

Items	Fiscal Year 1936	1937	1938	1939	1940 **
States	34	41	42	44	44
Hatcheries	1,017	1,239	1,478	2,033	2,300
Egg capacity of hatcheries	38,066,000	52,591,786	60,523,222	75,782,922	94,000,000
Breeding flocks	23,813	30,558	28,820	42,591	48,000
Breeding birds	3,522,409	6,535,907	5,948,498	8,653,568	10,000,000
Breeding birds tested for pullorum	2,053,159	4,227,733	3,937,619	6,772,031	8,500,000
(a)U.S.R.O.P. flock owners	*	301	298	317	300
U.S.R.O.P. flocks	190	352	353	396	390
Birds entered in trap-nest flocks	66,547	112,202	108,183	124,937	120,000
U.S.R.O.P. breeding pens	*	1,675	1,966	2,206	2,400
Females in U.S.R.O.P. pens	8,207	22,322	26,135	30,081	31,000

* Complete information not available for 1936.
** Estimated on basis of preliminary reports.
(a) U. S. Record of Performance.

Project 7. Certification of Pedigrees of Imported Registered Livestock:

Paragraph 1606 of the Tariff Act of 1930 provides for free entry of imported purebred livestock by citizens of the United States for breeding purposes, and this provision of the law is administered jointly by the Secretary of Agriculture and the Secretary of the Treasury. This Department's function is to vouch for the reliability and accuracy of books of record for purebred livestock and also for the identity of such animals offered for import. This work is regulatory, and comprises the examination of pedigrees of the animals imported, and certification to the accuracy thereof to the Collector of Customs at the port of entry for entry free of duty. The volume of importation varies somewhat from year to year. During the fiscal year 1940, certificates of pure breeding were issued for 14,929 animals, an increase of 1,118 head over the fiscal year 1939. The importations included 377 horses, 10,868 cattle, 2,668 sheep, 53 swine, 956 dogs, and 7 cats, the number of cattle and sheep having shown a material increase over the fiscal year 1939, and the other classes of livestock a slight decrease.

(c) DISEASES OF ANIMALS

Appropriation Act, 1941................	$462,000
Budget estimate, 1942..................	462,000

PROJECT STATEMENT

Projects	1940	1941 (estimated)	1942 (estimated)
1. Investigations of nonparasitic diseases of livestock:			
(a) Investigations of equine encephalomyelitis and forage poisoning........	$19,685	$19,090	$19,090
(b) Investigations of anaplasmosis of cattle..................................	11,653	11,415	11,415
(c) Investigations of rabies...........	5,209	5,315	5,315
(d) Investigations of swine erysipelas.	8,083	6,920	6,920
(e) Investigations of miscellaneous diseases, including glanders, blackleg, paratyphoid infection of swine, foot-rot, alkali disease, and other miscellaneous diseases and pathological conditions of animals........	22,927	23,518	23,518
(f) Investigations of brucellosis of cattle (Bang's disease or contagious abortion)......................	77,170	78,182	78,182
(g) Investigations of stock poisoning by plants............................	19,178	20,650	20,650
(h) Diagnosis and general investigations of poultry diseases, including laryngotracheitis, range paralysis, tuberculosis, pullorum disease, fowl pox...........	26,404	29,890	29,890
(i) Investigation of equine infectious anemia (swamp fever)...........	16,557	15,000	15,000
(j) Investigation of animal tuberculosis..................................	51,565	22,500	22,500
(k) Determination of various types of tubercle bacilli in the diagnosis of the disease......................	2,781	3,000	3,000
(l) Investigations of paratuberculosis (Johne's disease) of cattle....	3,312	3,000	3,000
(m) Investigation of methods of producing immunization against hog cholera.........................	21,112	27,520	27,520
(n) Investigations of periodic ophthalmia of equines................	10,047	10,000	10,000
Total, Investigations of nonparasitic diseases of livestock..................	295,683	276,000	276,000

PROJECT STATEMENT - (continued)

Projects	1940	1941 (estimated)	1942 (estimated)
2. Investigations of parasitic diseases of animals:			
(a) Index catalog of medical and veterinary parasitology and maintenance of parasite collection.....	$ 8,679	$8,500	$8,500
(b) Investigations of poultry parasites..............................	19,718	20,300	20,300
(c) Investigations of swine parasites	24,071	22,800	22,800
(d) Investigations of parasites causing and transmitting anaplasmosis in cattle................	10,495	11,300	11,300
(e) Investigations of ox warbles in cattle and of related arthropod parasites...........................	28,839	30,000	30,000
(f) Investigations of liver flukes in ruminants..........................	15,232	15,900	15,900
(g) Investigations of internal parasites of ruminants................	24,782	24,300	24,300
(h) Investigations of horse parasites	9,592	11,300	11,300
(i) Investigations of miscellaneous parasites, including parasites of dogs, cats, wild animals, etc.......	17,283	16,300	16,300
(j) Investigations for the development of anthelmintics and insecticides for the destruction of parasites...........................	15,432	15,300	15,300
(k) Investigations of trichinosis in swine...........................	9,912	10,000	10,000
Total, Investigations of parasitic diseases of animals....................	184,035	186,000	186,000
Total obligations..........................	479,718	462,000	462,000
Transfer from "Eradicating cattle ticks", Bureau of Animal Industry......	-13,750	- -	- -
Transfer from "Inspection and quarantine", Bureau of Animal Industry.......	- 8,000	- -	- -
Transfer from "Meat inspection", Bureau of Animal Industry..............	- 1,250	- -	- -
Unobligated balance.....................	5,282	- -	- -
Total appropriation..........	462,000	462,000	462,000

WORK UNDER THIS APPROPRIATION

General. Items under this appropriation include research investigations into the cause, prevention, and treatment of the infectious, non-infectious, and parasitic diseases of livestock, including poultry, and stock poisoning by plants. These investigations include both field and laboratory studies and have for their object the development of the necessary information that will lead to the formulation of methods for the control and eradication of the various diseases and parasites that are the cause of heavy loss to the livestock industry of this country. Complete information as to the cause and mode of transmission of diseases and parasites is necessary before the most effective measures can be taken for their control. Research in the past has made it possible to formulate and put into effect practical measures for the control and in some cases the eradication of diseases and parasites of high economic importance. This has resulted in great benefit to the livestock industry. Complete information, however, on many important diseases and parasites is still lacking so that effective measures for the reduction of losses occasioned by them must await further research.

Project 1. Investigations of Nonparasitic Diseases of Livestock:

Objective: To obtain information leading to measures for the control of the diseases of domestic animals and poultry, which are of particular importance at the present time; and to obtain similar information on various plants suspected of being poisonous in order to reduce losses to the livestock industry from these sources.

The Problem and Significance: Since the organization of the Bureau of Animal Industry investigations of nonparasitic diseases of livestock have been a major item in its work. Without the safeguards developed and maintained by the Bureau, our herds and flocks would be decimated by disease to an extent that the production of adequate livestock and meat food supplies would be endangered. Losses from nonparasitic diseases of livestock, including poultry, are estimated at $130,000,000 annually. Annual losses from some major diseases are as follows: Bang's disease $40,000,000; tuberculosis $20,000,000; hog cholera $7,000,000; and anthrax $500,000. Losses from poultry diseases, exclusive of tuberculosis, amount to approximately $50,000,000 annually. This huge waste can be greatly reduced through further research in veterinary science, together with practical application of the results obtained.

Plan and Progress of Work: Investigations are made into methods of diagnosis, cause, mode of transmission, and methods of prevention, treatment, and control of the more important infectious and noninfectious diseases of livestock and poultry. These investigations embrace such diseases as contagious abortion (Bang's disease), equine encephalomyelitis, equine infectious anemia, hemorrhagic septicemia, anaplasmosis, rabies, anthrax, swine erysipelas, tuberculosis, and miscellaneous diseases and pathological conditions of animals including the more important poultry diseases such as range paralysis, pullorum disease, pox, tuberculosis, etc. These investigations embrace field and laboratory activities. Studies of the diseases as they exist in the field are made and the bacteriological, sero-

logical, pathological, immunological, and animal inoculation studies are conducted in the laboratory. The investigations of stock-poisoning plants include field observations to determine the relationship between poisoning and conditions under which it occurs; the collection and feeding to different animals of the suspected plants; the chemical investigation of these plants to isolate and determine the chemical nature of the toxic substances, and attempts to find practical means either to prevent poisoning or counteract the effects of the toxic substances. These investigations are discussed in detail under the following work projects:

(a) Equine Encephalomyelitis and Forage Poisoning Investigations.---Losses in horses in various parts of the country have occurred for many years which until a few years ago had been generally considered to be due to spoiled forage (forage poisoning). Particularly severe losses have occurred in certain years. In 1930 it was shown that a severe epizootic in horses in California was due to an infectious agent, a filterable virus, producing an inflammation of the brain and spinal cord (encephalomyelitis). The specific virus disease has been definitely identified by laboratory means in 29 States and has been diagnosed clinically or pathologically in at least 15 other States. Further work is under way to determine positively the existence of the virus disease in the latter States. Additional information is being sought on the modes of transmission, including an explanation of the manner in which the infection is carried over from one epizootic to another and on improved methods of diagnosis and means of immunizing horses against the disease. During 1938 the virus of this disease was found to be the cause of encephalitis in children in Massachusetts. This is the first authentic report of the infection in man. Recent outbreaks of a somewhat similar disease following in the wake of the virus infection are being investigated.

(b) Anaplasmosis Investigations.--Anaplasmosis is a disease of cattle somewhat similar to tick fever. It was definitely recognized in the United States in 1924 and now exists in about 21 States. Control measures employed in other countries are not applicable to this country. The objective in these investigations is to determine the modes of transmission of the disease and to develop a serological test for the diagnosis of the carrier animals. Although means of partially controlling the disease have been found, the development of an immunizing agent that is both safe and effective is an object of these investigations, as is also the determination of effective therapeutic means of combating the disease and freeing the carrier animal of infection.

(c) Rabies Investigations.--This project covers studies on the diagnosis and methods of control of rabies in dogs and other animals. In recent years particular attention has been given from time to time to a study of the efficacy of the prophylactic vaccination of dogs as a means of controlling outbreaks of the disease.

(d) Swine Erysipelas Investigations.--It has been found in recent years that swine erysipelas in the acute and chronic form exists in a number of the States. These investigations are conducted in an endeavor to improve on the agglutination test which is now used for diagnosing the

disease so that this may be made available for a practical field test for the diagnosis of the disease. Studies are being made on the factors that enhance the pathogenicity of the causative agent of the disease and on outbreaks of the disease in the field, the latter to gain information on control measures. Experiments are being conducted to develop a safe and effective means of vaccination where the disease occurs in large hog-breeding and feeding establishments.

(e) Miscellaneous Disease Investigations.--The diseases falling in this group, which include glanders, blackleg, paratyphoid infection of swine, foot-rot, alkali disease, anthrax, hemorrhagic septicemia, and other miscellaneous diseases and pathological conditions of animals, are at this time subjects for study as occasion demands. While some of these diseases were at one time major problems, earlier special studies resulted in finding effective means for their control. The present activities concerning these diseases are largely those of diagnosis, since proper diagnosis is the first essential in formulating measures to combat outbreaks of disease.

(f) Investigations of Brucellosis of Cattle (Bang's Disease).--Bang's disease has for many years been growing in importance until it now ranks first among diseases that plague the dairy and cattle-raising industries. The object of this research is to gain sufficient knowledge of the disease to be able at least to reduce its ravages and, if possible, bring it under control and eradicate it. The incidence of this disease has been materially reduced in many States as a result of a Federal-State cooperative control program based on the test-and-slaughter method. The results of field trials on calfhood vaccination, while as yet incomplete, continue to be favorable and indicate that vaccination may be of value in increasing the resistance of animals in infected herds and thereby greatly increase calf production.

(g) Stock Poisoning by Plants.--The losses in livestock caused by poisonous plants are frequently very severe. It is estimated that the average annual loss is about one million dollars and in some years may reach several times that figure. Work is being carried on to determine what plants are responsible for these losses and to find means to prevent poisoning and to treat affected animals. The cause of a serious disease which has resulted in an annual loss of several thousand sheep has been traced to two poisonous plants. This discovery made it possible to formulate practical means for avoiding the plants and eliminating the losses. Poisoning of livestock by prussic-acid bearing plants has resulted in losses in every part of the United States. An effective remedy for this type of poisoning has been developed and is being used wherever such plants cause trouble.

(h) Poultry Disease Investigations.--The principal diseases now under investigation are laryngotracheitis, range paralysis, tuberculosis, pullorum diseases, and fowl pox. These are widespread in distribution and are the cause of heavy losses to the poultry industry. In addition, a number of diseases to which poultry are susceptible but which are of lesser economic importance are subjects for study as suitable material becomes available and facilities permit. The objective is to formulate adequate control measures.

(i) Swamp Fever Investigations.--Swamp fever is a widely distributed disease of horses and mules which at times has been of economic importance in certain sections of the United States. In 1927 the disease assumed economic proportions in the Mississippi Delta region, and investigations are now being conducted looking to the development of some treatment that will be effective either as a preventive or as a cure for the disease. Work is being conducted to develop a test for the detection of carriers of the infection as a means of controlling and eventually eradicating the disease.

(j) Tuberculosis and Tuberculin.--The investigation of animal tuberculosis was one of the earliest major projects of the Bureau of Animal Industry. Much has been learned of the nature of the disease, the manner in which it is spread, the methods of diagnosis, and means of prevention and control. Present methods of eradicating the disease are based on this work. The object of this investigation is to gain knowledge relative to the disease which will make possible its eradication in cattle, hogs, chickens, and other animals affected by the different types of tubercle bacilli. With the decrease in the incidence of tuberculosis in cattle, it has become apparent that there are other causes of reaction to tuberculin in cattle than the bovine tubercle bacillus. Studies are being made of the causes of such non-specific sensitization in the hope of developing means of differential diagnosis that may be made applicable to field testing.

(k) Types of Tubercle Bacilli.--In specimens representing lesions found in tuberculin reactor animals slaughtered in connection with the national program of tuberculosis eradication the finding of tubercle bacilli confirms the tuberculin test. The object of this investigation is to determine the types of tubercle bacilli, whether bovine, human, or avian, that are found in these lesions, in order to furnish the information necessary from the standpoint of tuberculosis eradication.

(l) Johne's Disease Investigations.--Johne's disease (paratuberculosis) is a malady of cattle which, like tuberculosis, is caused by acid-fast microorganisms. Like tuberculosis, infection in the early stage of the disease can not be detected by clinical means, yet these animals may be spreaders of the infection to healthy cattle. While the disease has been recognized in the United States for a number of years, it apparently is becoming more prevalent and is causing considerable loss, especially in the dairy industry. A diagnostic agent similar to tuberculin and known as Johnin was developed in 1914. A commercially prepared intravenous Johnin became available in 1927 but proved rather unsatisfactory. In 1932 the Bureau began the preparation of an intradermic Johnin similar to intradermic tuberculin. This product, while more satisfactory than the intravenous Johnin, is as yet in an experimental stage. The object of this investigation is to improve the intradermic Johnin, looking to the ultimate development of a diagnostic agent as effective as intradermic tuberculin, and to apply this product in the field for the detection of infected animals so they may be removed from the herds.

(m) Methods of Producing Immunization Against Hog Cholera.--At times hog cholera has severely injured the hog-raising industry, losses having reached 6,000,000 hogs (valued at $65,000,000) in a single year. Present methods of immunization are expensive and not invariably safe or

successful. A cheaper and more dependable method is being sought, either through improved utilization of virus and serum or through a harmless but effective vaccine.

(n) Investigations of Periodic Ophthalmia of Equines.--Periodic ophthalmia of equines has been known to exist in the United States for many years and is characterized by a recurring inflammation of the eye which usually terminates in blindness of one or both eyes. The condition is quite widespread, particularly in the Middle West and East. Indications are that the disease is on the increase. While it is rather difficult to estimate the losses occasioned annually by this disease, they are known to be heavy. Little is known about the cause of the disease but it is generally believed to be of an infectious nature of the type of a filterable virus. Research work on periodic ophthalmia is handicapped by the fact that the experiments must be conducted on horses and mules, which makes the procedure quite expensive. As a result, experimental work, both in this country and abroad, has been very limited, and little or no information of practical value in the control of the disease has yet been developed.

Project 2. Investigations of Parasitic Diseases of Animals:

Objective: To improve the existing methods of eradicating or controlling parasites that injure livestock and poultry and to develop methods of coping with the many species of parasites for which no control measures have as yet been developed and/or which are not as yet amenable to medicinal treatment.

The Problem and Its Significance: Livestock and poultry throughout the United States are subject to the attacks of external and internal parasites, some of which are acquired through direct contact and others through the contamination of pastures, dry feed and water with cysts, eggs and larvae of protozoan and metazoan parasites; many species of parasites are transmitted by vectors or intermediate hosts upon which livestock and poultry feed, or which sting, bite, or otherwise injure the hosts' skin, thereby introducing the infective stages of parasites. Once introduced into a herd or flock, parasites increase at enormous rates, as a rule, and produce unthriftiness and stunting, and, in the case of young and debilitated animals, they produce marked morbidity and death. Owing to a more or less continuous increase in the restriction of available pastures on the farm and range, due to overstocking, parasitism has been assuming increasing importance as a factor in livestock production and as a cause of loss to the meat industry through condemnations under meat inspection. Much of the stunting and unthriftiness in livestock and poultry, and many of the deaths in young animals and birds, are due to internal parasites, such as stomach and intestinal worms, tapeworms, lungworms, nodular worms, liver flukes, coccidia and other protozoan parasites; condemnations of carcasses or parts under Federal meat inspection result from the invasion of parasites such as kidney worms, tapeworm cysts, liver flukes and larval nematodes into the edible portions. In the South it has been determined by the meat industry that losses under meat inspection due to parasites average 75 cents per 200 pounds of live weight of hogs. Condemnations of cattle livers due to liver flukes are

common in the Pacific Coast States, the Rocky Mountain States and the Gulf Coast Basin, these losses amounting to about $500,000 annually. External parasites, namely, ox warbles, demodectic mange mites, lice and others, produce serious injuries to hides from which the leather industry of this country experiences enormous losses annually.

Plan and Progress of Work: To develop a practical and scientific basis for eradicating or controlling parasites, studies are conducted on the distribution of these pests in the major agricultural regions of the United States, these investigations taking into consideration climate, soil types, pastures, and topography; methods are developed for accurate diagnoses, based on the study of the morphology of parasites and of their eggs and larvae; the infective states are investigated from the standpoint of their ecology, with the view to developing methods for their destruction; the mode of transmission is determined by experiments in the laboratory and observations in the field; the life cycles are investigated by scientific methods in the laboratory and in the field; the injuries produced and symptoms exhibited by experimentally-infected animals are noted in order to develop sound methods for field diagnosis; the immunological responses, if any, are investigated as aids in control; weak links at which the vicious cycles of parasites may be broken are explored; intermediate hosts are investigated and methods are devised for their eradication or control; field tests to develop promising control measures are conducted on a small scale under conditions that enable the investigators to determine the different factors that might be involved; and, finally, the most promising control measures are tested in the field in cooperation with farmers and stockmen, and control measures are adapted to meet varying conditions existing in different parts of the country.

To meet the ever-pressing need for affording infected animals prompt relief from the drain of parasitic infestations and saving the lives of young animals that have but little resistance to cope with mass attacks by parasites, experiments are conducted with drugs and chemicals to determine effective and inexpensive methods of destroying external parasites on, and removing internal parasites from livestock and poultry. Investigations are conducted also to develop practical methods of destroying the infective stages of parasites in the manure, which is the most fertile source of parasitic infestation on the farm and range.

Most of the available information concerning the identity and mode of transmission of and control measures for stomach worms, intestinal worms, and nodular worms of cattle, sheep and goats; roundworms, kidney worms and lungworms of swine; gapeworms and other parasites of poultry; tapeworm cysts in hogs, cattle, and sheep; trichinae in swine; and coccidia in animals and poultry, was determined by the investigations outlined. Control measures for swine roundworms and kidney worms and many treatments for the removal of parasites from animals and poultry, including the discovery of such well-established remedies as carbon tetrachloride, tetrachlorethylene and the recently introduced drugs, phenothiazine and barium antimonyl tartrate, resulted from investigations noted above. Practically all of the requirements under Federal meat inspection designed to protect the public from acquiring trichinosis and tapeworm infestations also resulted from the scientific investigations on parasites carried out under this program.

The work is organized under the following projects:

(a) Index Catalog of Medical and Veterinary Parasitology and Maintenance of Parasite Collection.--The object of this project is to maintain a complete catalog and index of the world's literature on parasitology. This index catalog provides a basis for research and affords prompt information in answering correspondence and in solving problems that arise in connection with the Bureau's regulatory work.

(b) Poultry Parasite Investigations.--The poultry industry of the United States suffers large losses because of parasites of poultry, including tapeworms, roundworms, and protozoan organisms that produce coccidiosis and blackhead. The objective of these investigations is to develop methods of protecting the industry from such losses by ascertaining through research effective treatments and control measures.

(c) Swine Parasite Investigations.--Swine parasites are the cause of large losses to the industry. Roundworms, kidney worms, nodular worms, and lungworms interfere seriously with the growth of swine and are important factors in the mortality of young pigs. The object of the work under this project is to lay a foundation of scientific fact on which to build measures for the control of parasites and to make available to the industry the data obtained so that losses may be reduced.

(d) Parasites Causing and Transmitting Anaplasmosis in Cattle.--In 1924 and 1925 it was found that anaplasmosis was prevalent in the United States in areas outside the region in which cattle-fever ticks were present, indicating that the eradication of the cattle tick, although resulting in the suppression of piroplasmosis, did not control anaplasmosis. Consequently the problem of anaplasmosis was made a project for consideration, the object being to ascertain what vectors carry anaplasmosis and to develop control measures of any practical sort.

(e) Ox-Warble and Related Arthropod Parasite Investigations.--The object of this project is (1) to lay a foundation for the eradication of ox-warbles from the United States, since these parasites cause losses, principally by damage to hides, amounting to millions of dollars annually; (2) to develop practical methods of controlling grub in the head of sheep; and (3) to ascertain effective methods of controlling demodectic mange mites of cattle, sheep ticks, and other parasites that damage the hides of livestock.

(f) Liver Fluke Investigations.--A survey of the fluke situation in 1912 indicated that the sheep liver fluke was prevalent along the Pacific Coast and the Gulf Coast, with extensions up certain river valleys to inland States. More recent surveys indicated that the fluke was spreading and was present in about 30 States, including many which were free from flukes in 1912. The damage to cattle livers alone has become an important item in connection with the increased value of livers in the treatment of pernicious anemia in man. In some sections of the United States a sizeable percentage of the lamb crop succumbs to liver-fluke infestation. Investigations are in progress to develop methods of controlling aquatic snails that serve as vectors for liver flukes.

(g) Internal Parasites of Ruminants.--Previous investigations have developed or standardized several treatments for stomach worms and other roundworms of sheep. The object of the project is to ascertain the basic facts in connection with cattle and sheep parasites and to develop treatments and control measures. Parasites cause more losses in sheep than do any other disease agents and in many places are the limiting factor in sheep production. A breeding disease of cattle, trichomonad infection, is known to produce an infection of the uterus, abortion, and sterility.

(h) Horse Parasite Investigations.--Horses in general are menageries of parasites, many of which are highly injurious because of their blood-sucking habits and are the cause of considerable losses. The object of the work under this project is to lay a foundation of scientific fact on which to build control measures and to make available to the people of the United States the data obtained so that losses may be reduced.

(i) Miscellaneous Parasite Investigations, including Parasites of Dogs, Cats, Wild Animals, etc.--Parasites of sheep, goats, and cattle are identical in many cases with parasites affecting deer and other wild ruminants, and some of our most important parasites of sheep and cattle have originated as parasites of wild ruminants in recent times. The same is true of parasites of domesticated and wild birds and other animals, and any competent study of parasites of domesticated animals must take cognizance of parasites of wild animals. A number of parasites of dogs are transmissible to man, and this fact gives the parasites of dogs special importance.

(j) Anthelmintics and Insecticides for the Destruction of Parasites.--The original object of this project was to establish the value of drugs in common use or at least recommended in the literature for the control of livestock parasites. This has been done. The next objective was to develop more effective drugs, and this has been done in some cases and is still being carried on effectively. A further objective is to ascertain basic correlations between the efficacy of a drug and its chemical composition and physical properties, and such investigations are now actively under way so that treatment for the removal of parasites can be established on a scientific rather than an empirical basis.

(k) Investigations on Trichinosis in Swine.--The available evidence indicates that nearly 20 percent of the population of this country acquire an infection with trichinae. While most of these infections are nonclinical, serious outbreaks, due to eating raw or imperfectly cooked pork, occur from time to time. The object of the work under this project is (a) to develop methods of devitalizing trichinae by refrigeration and curing, (b) to improve existing methods of processing designed to destroy trichinae, in keeping with new developments in the meat industry, and (c) to discover a test for diagnosing trichinosis in swine immediately before slaughter.

(d) ERADICATING TUBERCULOSIS AND BANG'S DISEASE

Appropriation Act, 1941	$4,300,000 (a)
Transferred in the 1942 Estimates to "Salaries, Office of the Secretary"	- 6,860
Net direct appropriation, 1941	4,293,140
Budget Estimate, 1942	5,843,140 (b)
Increase	1,550,000

(a) Together with $4,000,000 of the unobligated balance under this appropriation for the fiscal year 1940.

(b) Together with $750,000 of the appropriation under this head for the fiscal year 1941 estimated for reappropriation in 1942. (See Project Statement and explanation which follow).

PROJECT STATEMENT

Projects	1940	1941 (Estimated)	1942 (Estimated)	Decrease
1. Eradicating tuberculosis in livestock (including poultry)..	$2,156,798	$2,171,000	$1,796,000	-$ 375,000(1)
2. Combating Bang's disease in cattle	4,598,013	5,177,140	4,602,140	-575,000(2)
3. Experimentation in diseases of livestock	98,493	195,000	195,000	- -
Total, Eradicating tuberculosis and Bang's disease	6,853,304	7,543,140	6,593,140	-950,000
Transfer to "Salaries, Office of the Secretary"	+5,896	- -	- -	- -
Prior year balances available ...	-4,000,000	-4,000,000	-750,000	+3,250,000
Unobligated balance	5,440,800	750,000	- -	-750,000
Total	8,300,000	4,293,140	5,843,140	+1,550,000

DECREASES

The estimate for 1942 represents an increase of $1,550,000 in direct appropriation for this item, but taking into account reappropriations of prior year balances available in 1941 and estimated for 1942, there is a reduction of $950,000 in the program for 1942, as follows:

(1) <u>A decrease of $375,000 in indemnities for cattle slaughtered on account of tuberculosis</u>. Due to the progress of the area testing program in the last remaining State, California, there will be a reduction in the number of reactors there. In the retesting work, which is conducted in modified accredited areas throughout the country to safeguard against reinfection, it is expected that there will also be a reduction in reactors.

(2) A decrease of $575,000 in indemnities for cattle slaughtered on account of Bang's disease. Over a period of years the Bureau has developed a vaccine to be used in artificially immunizing calves against Bang's disease, and encouraging results have been obtained in field studies of calfhood vaccination in recent years. A plan for the official recognition of calfhood vaccination has been presented to State livestock sanitary officials and it is expected that the plan will be recognized in several States. In such States it is anticipated that many herd owners where there is a rather high degree of infection will follow the calfhood vaccination plan and not dispose of all their reactors at one time. It is also expected that there will be a reduction in the number of reactors because of the progress made in cleaning up the disease in many areas under the test-and-slaughter method.

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Tuberculosis eradication has been in progress since 1917. Since 1934 both regular and special funds (Jones-Connally and Section 37, Act of August 24, 1935) have been used for this purpose. Bang's disease eradication was inaugurated in the fiscal year 1935, and this work, together with special experimental work on livestock diseases as authorized by Section 37, was financed exclusively with special funds through the fiscal year 1938. The 1939 Agricultural Appropriation Act provided for continuation of tuberculosis eradication, Bang's disease eradication, and special experimentation under one consolidated appropriation item entitled "Eradicating tuberculosis and Bang's disease," with a direct appropriation of $5,403,000, together with the unexpended balance of the special funds estimated at $7,827,000, making in all $13,230,000, of which approximately $4,000,000 remained unobligated and was reappropriated for 1940.

The 1940 Agricultural Appropriation Act under the item "Eradicating tuberculosis and Bang's disease," appropriated $8,300,000, together with the unexpended balance of the special funds estimated at $4,000,000.

The $4,000,000 unexpended balance of the special funds remained unobligated in the fiscal year 1940 and was reappropriated under the 1941 Act, which also provided for a direct appropriation of $4,300,000, making $8,300,000 available for the fiscal year 1941. Present indications are that $7,550,000 of that amount will be obligated during the fiscal year 1941, leaving unobligated $750,000, which will be available for reappropriation in 1942.

Table I, which follows, shows obligations of regular and special funds for the fiscal years 1934 through 1940; allotments, 1941; and the Budget Estimate, 1942.

Table II shows, by States and Territories, the allotments of funds for tuberculosis and Bang's disease work during the fiscal year 1941.

Table III shows the status of Jones-Connally and Section 37 funds, from which the unexpended balance will be available for 1942.

TABLE I.—STATEMENT OF OBLIGATIONS AND ALLOTMENTS FOR ERADICATING TUBERCULOSIS, COMBATING BANG'S DISEASE, AND SPECIAL EXPERIMENTATION IN DISEASES OF LIVESTOCK, FISCAL YEARS 1934-1942.

	Eradicating Tuberculosis			Combating Bang's Disease			Experimentation in Dis. of Livestock		Total
	Reg. Funds	Jones-Connally & Sec. 37	Total	Reg. Funds	Jones-Connally & Sec. 37	Total	Reg. Funds	Sec. 37	
Obligations:									
1934	3,877,293	---	3,877,293	---	---	---	---	---	3,877,293
1935	1,966,490	9,500,000	11,466,490	---	10,687,175	10,687,175	---	---	22,153,665
1936	1,636,817	5,961,671	7,598,488	---	14,345,116	14,345,116	---	13,297	21,956,901
1937	1,429,514	2,720,962	4,150,476	---	13,481,908	13,481,908	---	106,130	17,738,514
1938	1,558,956	1,775,000	3,333,956	---	11,653,062	11,653,062	---	129,938	15,116,956
1939	1,603,000	739,439	2,342,439	3,800,000	2,937,786	6,737,786	---	97,844	9,178,069
1940	2,156,798	---	2,156,798	4,598,013	---	4,598,013	96,493	---	6,853,304
Allotments:									
1941	2,171,000	---	2,171,000	1,927,140	3,250,000	5,177,140	195,000	---	7,543,140
Budget Estimate, 1942	1,796,000	---	1,796,000	3,852,140	750,000	4,602,140	195,000	---	6,593,140
Grand Total	18,195,868	20,697,072	38,892,940	14,177,293	57,105,047	71,282,340	486,493	347,209	111,010,982

TABLE II.--ERADICATING TUBERCULOSIS AND BANG'S DISEASE

1941 Allotments
(Combined funds)

State	Eradicating Tuberculosis		Combating Bang's Disease		Total
	Salaries and Expenses	Indemnities	Salaries and Expenses	Indemnities	
Eradicating tuberculosis and combating Bang's disease:					
Alabama	$18,000	$3,000	$140,000	$100,000	$261,000
Arizona	4,000	4,000	25,000	7,000	40,000
Arkansas	7,000	1,000	100,000	35,000	143,000
California	165,000	190,000	1,000	--	356,000
Colorado	17,000	3,000	21,000	--	41,000
Connecticut	17,000	15,000	2,000	10,000	44,000
Delaware	4,000	3,000	9,000	30,000	46,000
District of Columbia	120,000	--	178,140	--	298,140
Florida	10,000	5,000	77,000	60,000	152,000
Georgia	11,000	1,000	90,000	50,000	152,000
Idaho	8,000	1,000	55,000	25,000	89,000
Illinois	18,000	50,000	30,000	60,000	158,000
Indiana	40,000	10,000	24,000	--	74,000
Iowa	38,000	110,000	67,000	110,000	325,000
Kansas	30,000	15,000	25,000	50,000	120,000
Kentucky	18,000	2,000	25,000	15,000	60,000
Louisiana	12,000	2,000	75,000	50,000	139,000
Maine	15,000	1,000	14,000	40,000	70,000
Maryland	20,000	13,000	45,000	130,000	208,000
Massachusetts	17,000	25,000	1,000	--	43,000
Michigan	20,000	10,000	80,000	100,000	210,000
Minnesota	25,000	15,000	125,000	158,000	323,000
Mississippi	24,000	2,000	34,000	25,000	85,000
Missouri	18,000	1,000	80,000	50,000*	149,000
Montana	20,000	1,000	7,000	18,000	46,000
Nebraska	34,000	7,000	25,000	30,000	96,000
Nevada	11,000	1,000	9,000	--	21,000
New Hampshire	8,000	3,000	12,000	124,000	147,000
New Jersey	21,000	18,000	4,000	25,000	68,000
New Mexico	7,000	1,000	40,000	5,000	53,000
New York	50,000	130,000	13,000	180,000	373,000
North Carolina	12,000	1,000	60,000	40,000	113,000
North Dakota	60,000	10,000	60,000	25,000	155,000

*Legislature meets January 1941.

TABLE II - Continued

State	Eradicating Tuberculosis		Combating Bang's Disease		Total
	Salaries and Expenses	Indemnities	Salaries and Expenses	Indemnities	
Ohio................	$13,000	$15,000	$80,000	$275,000	$383,000
Oklahoma............	34,000	3,000	72,000	---	109,000
Oregon..............	15,000	20,000	110,000	40,000	185,000
Pennsylvania........	35,000	75,000	68,000	400,000	578,000
Rhode Island........	6,000	4,000	---	5,000	15,000
South Carolina......	6,000	1,000	25,000	1,000	33,000
South Dakota........	70,000	15,000	15,000	---	100,000
Tennessee...........	20,000	2,000	45,000	75,000	142,000
Texas...............	30,000	3,000	27,000	---	60,000
Utah................	8,000	7,000	35,000	25,000	75,000
Vermont.............	18,000	20,000	17,000	25,000	80,000
Virginia............	20,000	10,000	45,000	75,000	150,000
Washington..........	40,000	6,000	85,000	60,000	191,000
West Virginia.......	14,000	2,000	40,000	8,000	64,000
Wisconsin...........	45,000	25,000	100,000	300,000	470,000
Wyoming.............	4,000	1,000	18,000	1,000	24,000
Alaska..............	---	1,000	---	---	1,000
Hawaii..............	2,000	1,000	---	---	3,000
Puerto Rico.........	17,000	10,000	---	---	27,000
Total..........	1,296,000	875,000	2,335,140	2,842,000	7,348,140

Eradicating tuberculosis and combating Bang's disease.................. 7,348,140
Experimentation in diseases of livestock.............................. 195,000

Grand Total.. 7,543,140

TABLE III.--STATEMENT SHOWING STATUS OF $150,000,000 JONES-CONNALLY FUNDS AND $10,000,000 MADE AVAILABLE BY SECTION 37 OF ACT OF AUGUST 24, 1935

	Amount
Obligated 1934-1940 and Allotments 1941:	
Elimination of diseased cattle:	
Eradicating tuberculosis	$20,697,072
Combating Bang's disease	56,355,047
Combating mastitis	885,000
Experimentation in diseases of livestock	347,209
Total, Elimination of diseased cattle	78,284,328
Removal of surpluses:	
Dairy products	17,177,368
Cattle purchases	63,736,373
Total, Removal of surpluses	80,913,741
Estimated for Reappropriation for 1942:	
For combating Bang's disease	750,000
Uncommitted balance	51,931
Total	160,000,000

CHANGE IN LANGUAGE

The estimates include a proposed change in the language of this item as follows (new language underscored, deleted matter enclosed with brackets):

Eradicating tuberculosis and Bang's disease: For the control and eradication of the diseases of tuberculosis and paratuberculosis of animals, avian tuberculosis, and Bang's disease of cattle, [$4,300,000] <u>$5,843,140</u>, together with [the unobligated balances of the funds reappropriated under this head for the fiscal year 1940 by the Agricultural Appropriation Act for that year from unobligated balances of funds made available by the Act of May 25, 1934 (48 Stat. 805), and section 37 of the Act of August 24, 1935 (7 U. S. C. 612b)] <u>$750,000 of the unobligated balance of the appropriation made under this head for the fiscal year 1941</u>: Provided, That. . . . . . .

This change in language brings up to date the clause, carried annually hereunder for the past several years, authorizing the use of the unobligated balance of prior-year funds provided for the purposes of this appropriation. For 1942, it makes available a reappropriation of $750,000 of the unobligated balance of the appropriation made under this head for the fiscal year 1941.

WORK UNDER THIS APPROPRIATION

General. The work under this appropriation provides for the eradication of tuberculosis in livestock (including poultry), paratuberculosis in cattle, and Bang's disease (Brucellosis or contagious abortion) in cattle, with

partial compensation to owners of cattle condemned and destroyed because of being affected with the disease, and experimentation in diseases of livestock. The work is divided into the following lines of activity.

Project 1. Eradicating Tuberculosis in Livestock (Including Poultry):

Objective: The eradication of tuberculosis in livestock (including poultry).

The Problem and Significance: Tuberculosis, when present, is one of the most serious diseases of cattle, swine, and poultry because of its effect in reducing production and causing a considerable loss of meat condemned as unfit for food. It is also a menace to the public health, as it may be transmitted to children using unpasteurized milk and dairy products from infected cows, causing tuberculosis of the glands and bones. Much has been done in eliminating bone tuberculosis, which frequently manifests itself in humans as hunchback, by the eradication of tuberculosis in cattle.

While the disease has been found in practically all sections of the United States, it is much more prevalent in some sections than in others. Tuberculosis among poultry is very prevalent in the Central and North Central States and, in some counties, has been found to exist to a very high degree. In swine it may progress to a point where it becomes generalized, but in most of the carcasses showing evidence of the disease on postmortem examination only slight lesions of the cervical or mesenteric lymph glands are found. Avian (fowl) tuberculosis is particularly difficult to eradicate because of the fact that the organisms are so resistant. The bacilli will live for many months in the soil. It is quite a common practice, in many localities where the disease exists, for the poultry and swine to occupy the same premises during at least a part of the day. This practice causes the disease, when present, to spread very rapidly among swine.

Plan and Progress of Work: Since the inauguration of the cooperative tuberculosis eradication work by the Department and the various State livestock sanitary officials in 1917, there has been a marked reduction in the degree of infection of tuberculosis. At the beginning of the campaign, approximately 5 percent of the cattle tested disclosed infection of tuberculosis, whereas, during the fiscal year 1940, less than one-half of 1 percent reacted to the test. During the first few years of the campaign the work was confined chiefly to the tuberculin testing of individual herds of cattle, either on a voluntary basis or under the rules and regulations in effect in the States in which the herds were located. This feature of the work was followed by what is known as the area plan, which consists in the tuberculin testing of all cattle in a given area, such as a county. The reactors are removed for slaughter, and the premises previously occupied by them are thoroughly cleaned and disinfected. Retests of infected herds are conducted at proper intervals, and if the infection is found to be more than 1 percent, all the cattle in the area are again tuberculin tested and the same procedure followed. When the degree of infection in the cattle in a county is found

to be less than one-half of one percent the county is declared to be a "modified tuberculosis-free accredited area." In July 1923 the first counties in the United States were given that classification, and additional counties have been so classified each succeeding year. On July 1, 1940, a total of 3,067 counties, or 99.9 percent of all the counties in the United States, were in that status. All the counties in the United States are now modified accredited areas. The District of Columbia, all the municipalities in Puerto Rico, and the entire Virgin Islands are also modified accredited areas.

In order to safeguard against reinfection, it is necessary to conduct a considerable amount of retesting of cattle in the modified accredited areas. The majority of this work is performed by veterinarians employed by the Department, the remainder being done by State and county veterinarians. Since the cooperative work was undertaken in 1917, approximately 229,714,000 tuberculin tests have been applied to cattle in this country, disclosing about 3,768,200 reactors. During the fiscal year 1940, tuberculin tests were applied to 12,222,318 cattle, disclosing 56,343 reactors, or 0.46 percent. On June 30, 1940, there were 284,757 fully accredited tuberculosis-free herds, containing 3,743,951 cattle. Approximately 6,191,000 herds, containing about 61,570,000 cattle, were under supervision for the eradication of the disease.

In combating avian tuberculosis, the veterinarians employed in the field cooperate with the local livestock sanitary officials and the owners of poultry flocks. Cooperation is also obtained from certain local organizations and the owners of hatcheries. During the fiscal year 1940, additional work under this project was conducted on an intensive basis in selected townships. All the poultry and swine in those townships were tuberculin tested, the reactors removed, and the premises disinfected as far as possible. This method has created considerable interest among flock owners, who demand that the plan be continued. In some States considerable work has been done in connection with the tuberculin testing of flocks of poultry from which eggs are supplied to commercial hatcheries. In case reactors are found, they are removed from the flock, and retests of the remaining fowls conducted at proper intervals. One of the most important features in connection with the eradication of avian tuberculosis is to dispose of the older fowls, that is, those that have completed their first laying period. This practice, in most instances, has been found to be a very profitable one. Much information along this line is furnished the flock owners by veterinarians engaged in the tuberculin testing of cattle, and is done at very little additional expense due to the fact that the veterinarian can observe the flocks and discuss the subject with the owners while he is on their premises applying the tuberculin test to the cattle. During the past fiscal year it was possible for these veterinarians to observe approximately 126,600 flocks, containing about 14,943,600 fowls, located in 10 States. About 16 veterinarians of the Department devoted practically all their time to the avian tuberculosis project, visiting about 11,100 farms and observing about 1,715,000 fowls. Infection was reported on 1,159 farms.

Paratuberculosis, or Johne's disease, exists to some extent among cattle in the United States. This is a difficult disease on which to make a diagnosis; however, during the past fiscal year tests were applied to 96 herds, containing 4,428 cattle, disclosing 383 reactors, or 8.6 percent.

This project also provides for the supervision of the disposition of bovine reactors to the tuberculin test which have been consigned to public stockyards for slaughter, and the supervision of the testing at such stuckyards of cattle to be shipped interstate for dairy or breeding purposes.

An important feature of the plan from the owners' standpoint is the payment of Federal indemnity for reactors slaughtered, as it assists such owners to purchase the necessary replacements and establish healthy herds. After the cattle have been found to react to the tuberculin test, they are appraised at their market value, taking into consideration their quality as breeding and dairy animals. They are marketed for slaughter by the owner, who receives the salvage. The Federal payment is limited to one-third of the difference between the appraised value of the animal and the salvage, not to exceed $25 for grade animals and $50 for registered purebred animals. Since July 1, 1938, Federal payment has been further limited to an amount not exceeding the total sum paid by the cooperating State. This limitation was in effect prior to the fiscal year 1935, at which time emergency funds (the Jones-Connally Act and Section 37 of the Act of August 24, 1935), usable without regard to any State payment, became available for the payment of Federal indemnities. Payment from all sources, including the salvage, cannot exceed the appraised value of the animal. During the fiscal year 1940, the average appraisal was $93.28; the average Federal payment $16.77; the average State payment $22.86, and the average salvage $37.91. Of the total reactors for which Federal indemnity was paid, 9 percent were registered purebred cattle. No indemnity is paid for steers or unregistered bulls. These same provisions apply to the payment of Federal indemnity for animals slaughtered on account of Johne's disease.

During the fiscal year 1940, approximately $894,000 was expended as Federal indemnity payments to owners of cattle condemned and destroyed on account of tuberculosis and Johne's disease. Approximately $1,263,000 was used for operating expenses, including salaries.

Project 2. Eradicating Bang's Disease in Cattle:

Objective: The eradication of Bang's disease (Brucellosis or contagious abortion) in cattle.

The Problem and Significance: Bang's disease (Brucellosis or contagious abortion) which is found in cattle in practically all sections of the United States, is the cause of serious loss to the cattle industry. It is much more prevalent in some localities than in others, the higher degree of infection being found in the larger herds where there has been a considerable exchange of animals. It is also more prevalent in

the larger milk-shed areas. Approximately 75 percent of all breeding trouble in cattle is caused by Bang's disease. Common results of the infection are premature birth of calves and sterility.

While it is difficult to determine even approximately the financial losses caused by this disease, estimates have varied from $25,000,000 annually to much larger amounts, most of which have been based on tangible or actual losses in various communities. No definite, searching survey has yet been made that has taken into account the tremendous intangible losses. Consequently all estimates probably have fallen far short of the actual losses, which include the probable value of a calf that is expelled dead, or is weak, or soon dies; the shrinking of beef in the beef animal; the diminished production of milk in the dairy animal; the temporary or permanent sterility that may follow the infection, and, not infrequently, the loss of the cow herself through infection. Serious as these are, there must also be taken into account the financial loss that the breeder of select purebred cattle suffers from interference with his breeding program because of the disease in his herd. A careful study made at the Storrs (Connecticut) Agricultural experiment Station several years ago showed that the loss per cow in milk production alone was over $100 annually. Another investigator, studying the economic factors of abortion of cattle, found that the total loss resulting from abortion in one of the university farm herds over a period of 27 years was $12,760. This did not include losses from cows giving birth to dead calves over 260 days' calving period. He also determined that the loss resulting from abortion in a good commercial grade herd of 16 cows was $135, and in a typical purebred herd $486 annually. Veterinarians and cattle breeders know that Bang's disease is a widespread, economically important evil. The trouble they have had because of it makes them more eager to discuss it than any other infectious disease of cattle, and we know, from general observations and special studies, that at the time the eradication campaign was inaugurated in July 1934 it was more widespread and common than it was some years ago. Unless the fight is continued, much of the energies and public funds expended in its eradication and control will have been wasted, and it will again constitute the major cattle disease problem in sections where good work has been done.

In recent years it has been shown that undulant fever in man is caused by the same germ that causes Bang's disease in cattle. A considerable number of such cases have been reported which resulted from the ingestion of Bang's disease germs in raw milk. Handling pork products coming from animals infected with Bang's disease is also a means of transmitting undulant fever to man. The disease is also spread to man by handling discharges and aborted fetuses from infected animals. While undulant fever would not be classed as a major health problem, it is, nevertheless, one to be reckoned with, and can be reduced to a minimum through the eradication of the disease in cattle. The dairyman and the breeder of meat-producing animals are aware of the possibility of persons contracting undulant fever from Bang's disease germs in raw milk, meat, and dairy products, and the possible influence this aspect of the disease may have on the market for their products.

Plan and Progress of the Work: The project for the control and eradication of Bang's disease in cattle was taken up in a cooperative manner in July 1934 with emergency funds (the Jones-Connally Act and Section 37 of the Act of August 24, 1935), at which time arrangements were made to test the cattle and make Federal payments to owners for reactors slaughtered. There has been a great demand for this work by cattle owners in many sections of the United States. During the fiscal year 1940, approximately 6,937,000 tests for this disease were applied to cattle, disclosing about 172,000 reactors, or 2.5 percent. Of these tests, a considerable number were retests, applied at proper intervals. The work is voluntary on the part of the cattle owner as far as the Federal Government is concerned. In some States the work is conducted on an individual-herd basis, while in others, where the disease does not exist to a very high degree, and where the sentiment of the cattle owners is much in favor of it, the testing is done under the area plan. Under this plan, all the cattle in the area, except steers and calves under 6 months of age, are tested and the reactors removed and slaughtered. Retests are applied at the required intervals. The owners are given instructions as to the proper sanitary methods to follow in order to eliminate the disease, as proper sanitation is a very important factor in its eradication. At the close of the fiscal year 1940, approximately 1,615,000 herds, containing about 12,315,000 cattle were under supervision throughout the United States. In some States the work has progressed considerably faster than in others. In 10 States more than 50 percent of the breeding cattle over 6 months of age are under supervision, while in 11 States from 25 to 50 percent of the cattle are in that status. In 12 States from 10 to 25 percent of the cattle are under supervision, and in the remaining 15 States less than 10 percent are under supervision. During the 6 years in which this work has been conducted, agglutination blood tests, including retests, have been applied to approximately 40,380,000 cattle, of which about 1,951,000 have been removed as reactors.

In December 1939 the plan of designating areas as practically free of Bang's disease was inaugurated. The testing of cattle and designation of such areas are similar to the methods so successfully used in the campaign against bovine tuberculosis. The regulations under which the work is conducted provide that whenever results of testing the dairy and breeding cattle 6 months of age or over, except steers, for Bang's disease indicate that the percentage of cattle that reacted to the test did not exceed 1 percent of the cattle tested, nor the infected herds more than 5 percent of the total number of herds, such a county may be declared a "modified accredited Bang's-disease-free area" for three years, by the cooperating State and Federal officials in charge of the work, provided that all infected herds shall be placed in quarantine. The cattle in these herds must be retested for the disease at intervals of from 30 to 90 days until all of them pass two successive negative tests and also pass a further negative test not less than 6 months from the date of the second negative test. The reactors are, of course, removed from the herds and disposed of in accordance with the State and Federal regulations. On February 1, 1940, as a result of testing and retesting the required cattle, the removal of reactors, and the cleaning and disinfecting

of infected premises, 209 counties, located in 17 States, were declared modified accredited Bang's-disease-free areas. On April 1, 1940, 59 additional counties, some of which were located in 3 additional States, attained that distinction. As a further result of the work accomplished during the fiscal year, 30 additional counties were so classified on July 1, 1940, making a total of 298 counties, located in 20 States, or 9.7 percent of all the counties in the United States, in which the degree of infection of Bang's disease had been reduced to 1 percent or less. These counties contain approximately 2,400,000 of the 53,000,000 cattle of this class in the United States. Area work is also being conducted in approximately 250 additional counties, located in 24 States.

For a number of years the Department has been engaged in conducting various experiments to develop, if possible, a satisfactory means of artificially immunizing cattle against Bang's disease. During the course of these experiments a viable vaccine was developed from a low virulent culture of the Brucella organism which, when used on calves in station-controlled experiments, has given very encouraging results. The results attained were sufficiently encouraging to suggest a further trial of the vaccine under natural conditions. Consequently, a field project designed for this purpose was begun in January 1936 under a tentative plan which provided for continuing the study over a period of 5 years. At that time 260 herds, located in 24 States, containing approximately 19,000 cattle, were selected for these trials. In these herds Bang's disease was demonstrated by actual test to exceed 15 percent. More than 15,500 calves between the ages of 5 and 7 months of age in these herds have been vaccinated to date. Of this number, over 4,000 have completed the first gestation, more than 1,200 the second, and about 200 the third. Further observations will be required to complete the project and provide sufficient information necessary to determine the dependability of the vaccine when used under natural conditions, but it is planned to release a progress report on the study during the latter part of the fiscal year 1941. This project also provides for the supervision of the disposition of Bang's disease reacting cattle at public stockyards to which they have been shipped for slaughter, and the production, at the Animal Disease Station, Beltsville, Md., of all the antigen used in the agglutination blood testing.

As is the case in the tuberculosis eradication work, an important feature of the plan in the eradication of Bang's disease, from the owners' standpoint, is the payment of Federal indemnity for reactors slaughtered, as it assists such owners to purchase the necessary replacements and establish healthy herds. After the cattle have reacted to the agglutination blood test they are appraised at their market value, taking into consideration their quality as breeding and dairy animals. They are then marketed for slaughter by the owner, who receives the salvage. Since July 1, 1938, the Federal payment has been limited to one-third of the difference between the appraised value of the animal and the salvage, but such payment cannot exceed $25 for a grade animal or $50 for a registered purebred animal. The owner cannot receive from all sources, including the salvage, a sum greater than the appraised value of the animal. Since May 1, 1939, the Federal payment has been further

limited to an amount not exceeding the payment made by the cooperating State. Prior to May 1, 1939, only a few States made indemnity payments for animals slaughtered, but during the fiscal year 1940 funds were provided in 35 States for such payment. Four additional States have made appropriations for such payment during the fiscal year 1941. During the fiscal year 1940, the average Federal payment was $14.96. In addition to this, the owners received an average salvage of $34.99. The average appraisal of cattle that reacted and were slaughtered was $90.85. In States making indemnity payments, the average was $17.12. Of the total reactors slaughtered, approximately 11.0 percent were registered purebred animals.

During the fiscal year ended June 30, 1940, approximately $2,218,000 was expended as Federal indemnity payments to owners for cattle condemned and destroyed. State indemnity payments during that period approximated $2,500,000. Approximately $2,380,000 was used by the Federal Government for operating expenses, including salaries, while the operating expenses of the various States were about $465,000.

Project 3. Experimentation in Diseases of Livestock:

Objective: To obtain information leading to measures for the control of infectious and non-infectious diseases of livestock which are of particular importance at this time, in order to reduce losses to the livestock industry from these sources.

The Problem and Its Significance: Simple procedures of accurate diagnosis are essential in efforts to control the infection in the field. Of no less significance is the public health problem because of the danger of communicating some of the infections from animal to man.

Plan and Progress of Work: Investigations are made into the cause, mode of transmission, and methods of treatment, prevention, and control of the more important infectious and non-infectious diseases of cattle which are of increasing economic importance. These investigations include field and laboratory studies of Brucellosis of cattle (Bang's disease or contagious abortion), bovine mastitis, anaplasmosis of cattle, nutritional deficiencies of cattle, bovine trichomoniasis, and calf scours.

This activity was started in 1936 with funds authorized by Section 37 of the Act of August 24, 1935. Two alleged remedies for Bang's disease which have been widely advertised have been subjected to critical tests. Researches in connection with calfhood vaccination against Bang's disease and the transmission of infectious abortion to cattle by swine have yielded considerable information thus far, but a large amount of work remains to be done in connection with these researches as well as on other problems relating to Bang's disease, mastitis, anaplasmosis, trichomoniasis, calf scours, and nutritional deficiencies of cattle.

(e) ERADICATING CATTLE TICKS

Appropriation Act, 1941	$325,000
Budget estimate, 1942	300,000
Decrease	25,000

PROJECT STATEMENT

Project	1940	1941 (estimated)	1942 (estimated)	Decrease
Eradicating cattle ticks	$411,138	$325,000	$300,000	-$25,000(1)
Transferred to "Animal Husbandry", Bureau of Animal Industry	+10,000	- -	- -	- -
Transferred to "Diseases of Animals", Bureau of Animal Industry	+13,750	- -	- -	- -
Unobligated balance	40,112	- -	- -	- -
Total	475,000	325,000	300,000	-25,000

DECREASE

(1) The reduction of $25,000 for tick-eradication work will be met by decreasing the number of temporary agents assigned thereto. The curtailment in the work will be chiefly in Florida, Louisiana, and Texas.

WORK UNDER THIS APPROPRIATION

Objective: To free the United States of the serious disease splenetic or tick fever by eradicating the cattle fever tick which is the only natural carrier of this disease.

The Problem: To establish and direct effective eradication methods in the several tick-infested States and to assist cooperating State agencies in conducting the work of eradication. To prevent reinfestation in tick-free areas by the proper treatment and control of livestock movements from tick-infested areas.

Significance: The chief economic importance of the cattle fever tick lies in the fact that this parasite is the only natural carrier of the disease splenetic or tick fever of cattle, and that so long as this disease is endemic in any region it discourages or prevents the development of the beef and dairy industries and particularly inhibits the improvement of the native stock by preventing the introduction of improved breeding cattle.

Progress of Work: Systematic dipping of cattle in an arsenical solution is conducted cooperatively with the States, under provisions of State laws. The eradication of the cattle fever tick by this means has resulted in practically eliminating the disease tick fever from a large section of the country that was formerly infected. Since this project was started in 1906, approximately 99 percent of the area then under Federal quarantine has been released. This includes not only quarantined areas in the continental United States, but the territories of Puerto Rico and the Virgin Islands as well. The area still remaining under Federal quarantine in continental United States is now confined to parts of Florida and Texas. The success of this project has resulted in a considerable expansion in the beef and dairy industries and a marked improvement in the quality of cattle grown throughout the South.

(f) HOG CHOLERA CONTROL

Appropriation Act, 1941	$112,728
Budget estimate 1942	105,000
Decrease	7,728

PROJECT STATEMENT

Project	1940	1941 (estimated)	1942 (estimated)	Decrease
Hog cholera control	$115,160	$112,728	$105,000	-$7,728 (1)
Unobligated balance	6,840	- -	- -	- -
Total	122,000	112,728	105,000	- 7,728

DECREASE

(1) The reduction of $7,728 for hog-cholera control will be met by reducing, by the equivalent of approximately three full-time veterinarians, the veterinary service rendered the several States cooperating in swine-disease control work.

WORK UNDER THIS APPROPRIATION

Objective: To assist swine growers in preventing outbreaks of hog cholera and in controlling this highly infectious and fatal disease of swine when outbreaks occur.

The Problem: To secure the widest application of effective preventive and control measures and thereby reduce losses from this disease; to demonstrate the importance of sanitary surroundings in preventing and controlling swine diseases; and to prevent the dissemination of swine diseases by controlling the movement of diseased swine or the exposure of healthy swine to an infected premise.

Significance: Hog cholera is the most serious disease of swine and is found in all sections of the country. It takes the highest death toll of all hog diseases and where uncontrolled is capable of ruining the swine industry.

Plan and Progress of Work: Thirty-one specially trained veterinarians are stationed in the principal swine growing sections of the country. These men consult with and assist veterinary practitioners and others in diagnosing swine diseases, and through meetings and by personal contact advise and demonstrate to farmers and others the approved methods of preventing and controlling swine diseases. During the fiscal year ending June 30, 1940, through their visits to farms and attendance at meetings, these veterinarians had opportunity for 61,511 farm inspections and consultations relating to swine diseases with farmers, veterinarians, State officials, and others. Educational work was continued by these veterinarians, who attended 332 meetings at which there was an attendance of 20,124 persons. Demonstrations in the use and efficacy of the serum treatments were given in the treatment of 34,337 hogs. During the year 7,023 outbreaks of cholera were reported to these veterinarians. These measures have greatly reduced losses from hog cholera and have prevented widespread outbreaks of this disease.

(g) INSPECTION AND QUARANTINE

Appropriation Act, 1941........................ $603,500
Budget estimate, 1942.......................... 603,500

PROJECT STATEMENT

Projects	1940	1941 (estimated)	1942 (estimated)
1. Scabies eradication.................	$146,877	$135,150	$135,150
2. Control over interstate shipment of livestock for the purpose of preventing the spread of communicable diseases...........................	290,893	273,705	273,705
3. Enforcement of the 28-hour law......	26,843	25,795	25,795
4. Determination by inspectors in the field of the existence of diseases...........................	20,461	15,930	15,930
5. Inspection and quarantine of import animals.....................	109,123	89,920	89,920
6. Supervision over the importation of hides and other animal by-products, forage, etc.........................	58,508	59,000	59,000
7. Inspection and testing of animals for export.........................	4,090	4,000	4,000
Total obligations.....................	656,795	603,500	603,500
Transfer to "Diseases of Animals", Bureau of Animal Industry...........	+8,000	- -	- -
Unobligated balance...................	15,205	- -	- -
Total appropriation.........	680,000	603,500	603,500

WORK UNDER THIS APPROPRIATION

General. Work under this appropriation includes the eradication of scabies and dourine in cooperation with the various States; the investigation of reported outbreaks of diseases among livestock to determine if they are communicable and, if so, assisting local authorities in their control and eradication; the application of tests in the field and in the laboratory for diagnostic purposes; the control over interstate movements of livestock as a means of preventing the dissemination of infections, which includes inspection at the principal market centers; the administration of the 28-hour law to prevent cruelty to animals in interstate transportation; the inspection and testing of livestock intended for export, to determine their freedom from disease, and the inspection of

fittings and accommodations on vessels on which they are to be transported; the inspection and quarantine of livestock offered for importation; control over import animal byproducts, hay and straw, etc., to prevent the introduction or dissemination of communicable livestock diseases; and the administration, jointly with the Treasury Department, of Section 306 of the Tariff Act of 1930, prohibiting the importation of domestic ruminants or swine, or chilled or frozen fresh meats derived therefrom, from countries where foot-and-mouth disease or rinderpest exists.

Project 1. Scabies Eradication:

Objective: The complete eradication of scabies or mange, a highly contagious disease of sheep and cattle, and the ultimate removal of State and Federal quarantine restrictions which are necessary so long as the disease continues to exist.

The Problem and Significance: To establish and direct eradication methods looking to the complete eradication of scabies or mange, a highly contagious skin disease of sheep and cattle. If this disease is unchecked it causes heavy losses in flesh, unthrifty condition, arrested growth, functional disturbances, low vitality, and increased mortality, all of which result in serious financial losses to livestock owners. Because of its communicable nature the disease is readily disseminated and complete eradication is important for the protection of the entire sheep and cattle industry.

Plan of Work: Eradication work is carried on in cooperation with the States involved, under written agreements with State livestock sanitary authorities. It consists of inspecting all sheep or cattle, as the case may be, in areas where scabies exists or has existed recently and causing all animals found to be infected or exposed to be dipped in an approved dipping solution under the supervision of Federal or State employees. Further inspections on ranges or premises are then made in order that any infection that may have escaped may be promptly discovered and the animals properly treated. Quarantines of premises or specified areas where infection has been determined to exist are applied by State authorities in order to control movements of livestock until the required treatments have been accomplished, and when necessary to prevent the spread of the disease to other States Federal quarantine also is imposed. During the fiscal year 1940, about 16,372,000 inspections were made and about 1,525,000 dippings were supervised in the field.

Project 2. Control Over Interstate Shipment of Livestock for the Purpose of Preventing the Spread of Communicable Diseases:

Objective: To prevent the setting up of new areas of infection by detecting animals at public stockyards affected with communicable disease and treating the animals, premises, and transporting vehicles in such a manner as to minimize the danger of spreading the disease; to furnish information to the State livestock sanitary officials to assist them in eradicating disease at the point of origin.

Problem and Significance: The problem is to inspect each animal in order that no animal affected with a contagious, infectious, or communicable disease may enter the stockyards proper and spread disease by mingling with the other animals in the yards. In order to serve the best interests of the livestock industry, the inspection must be thorough and without undue interference with the normal flow of the animals through the yards. Unless the force of inspectors is adequate, there is grave possibility of overlooking an animal in the early stages of disease which might result in the animal being shipped from the yards and setting up a new center of infection in the State of destination. The discovery at public stockyards of shipments of livestock affected with communicable diseases is a very important factor in tracing infection back to its source. In a great many instances the discovery at public markets is the first knowledge gained of the existence of an infectious disease in the district of origin. Notice is sent by Federal employees to State or local authorities, enabling them to take steps promptly to localize and eradicate outbreaks which would otherwise become widespread before information concerning them would reach the authorities. This project also covers the enforcement of the animal quarantine laws prohibiting the interstate movement of animals affected with or exposed to contagious, infectious, or communicable diseases.

Plan of Work: The inspection of livestock for interstate movement being an essential service in the control of disease, an inspection force is maintained at public stockyards to prevent the dissemination of livestock diseases by detecting, segregating, and supervising the proper treatment or other disposal of animals affected with or exposed to contagious, infectious, or communicable disease, and supervising the cleaning and disinfection of all cars, trucks and other conveyances used in transporting infected animals and all pens, chutes, and alleys in which such animals are handled.

Project 3. Enforcement of the 28-Hour Law:

Objective: To lessen cruelty to animals in the course of interstate transportation by preventing railroads from transporting them in interstate commerce for a period longer than 28 consecutive hours without unloading them in a humane manner into properly equipped pens for feed, water, and rest for at least 5 consecutive hours. The time of confinement may be extended to 36 hours upon written request of the shipper.

The Problem: To prevent the railroads from confining the animals in the cars for longer periods than the law provides and, also, to prevent the unloading of the animals into pens unsuitable for the proper feeding, watering and resting of livestock.

Significance: To insure the safe and humane handling of livestock by the railroads while in the course of interstate transportation.

Plan of Work: Waybills and other records of railroads are examined to determine whether the animals have been confined in cars in excess of the statutory period without unloading for feed, water, and rest, and whether the proper amounts of feed and water have been supplied. Pens maintained by the railroads into which animals are unloaded for feed, water and rest are inspected to determine whether they are suitable for that purpose. Apparent violations of the 28-hour law are transmitted to the Department of Justice for prosecution.

Project 4. Determination by Inspectors in the Field of the Existence of Disease:

Objective: Under this project assistance is given to State livestock sanitary authorities in investigating diseases among livestock that appear to be of a communicable nature and in control and eradication work when such diseases are found to exist.

The Problem and Significance: To prevent serious losses among livestock from communicable diseases such as dourine and encephalomyelitis of horses, anthrax, and foot-and-mouth disease. It is essential that prompt and correct diagnoses be made so that appropriate measures can be taken without delay.

Plan of Work: Inspectors in the field cooperate with State livestock sanitary authorities in making diagnoses, which in some instances include drawing of blood for forwarding to the laboratory for test, in arranging for the treatment or the destruction of animals affected, and in disseminating information among livestock owners concerning measures to be taken. All reports of suspected cases of foot-and-mouth disease are carefully investigated.

Project 5. Inspection and Quarantine of Import Animals:

Objective: To safeguard the livestock industry against serious losses by preventing the introduction of destructive communicable diseases from other countries.

The Problem and Significance: The inspection of all livestock offered for importation to determine freedom from disease is mandatory under the law. At certain ocean ports of entry it is necessary that facilities be provided and maintained for holding animals in quarantine in order to properly carry out the purposes of that law.

Plan of Work: Inspectors are assigned to stations along the international boundaries and on the seacoast to inspect animals, examine accompanying certificates and, when necessary, place the livestock in quarantine and maintain them under observation during specified periods. Animals in quarantine are subjected to certain diagnostic tests. Those found to be affected with, or to have been exposed to, any communicable disease are refused entry and are returned to the country of origin or destroyed.

Vessels having on board live animals as sea stores, originating in countries where foot-and-mouth disease or rinderpest exists, are not permitted to dock until the animals have been slaughtered and the space occupied by them disinfected under supervision. During the fiscal year 1940 approximately 689,300 animals were inspected, of which 45,177 were refused entry and 236 were quarantined.

Project 6. Supervision Over the Importation of Hides and Other Animal Byproducts, Forage, etc.:

Objective: To safeguard the livestock industry against losses from animal diseases of foreign origin by preventing the introduction and dissemination of such diseases through the medium of infected or contaminated animal byproducts, hay, straw, etc.

The Problem and Significance: Several serious diseases of livestock, such as foot-and-mouth disease, rinderpest, surra, and contagious pleuropneumonia, from which the United States is entirely free, exist in many countries with which we have active trade relations. In order to prevent the introduction of these diseases through the medium of imported materials, supervision and control are exercised over animal byproducts, hay, straw, etc., offered for entry.

Plan of Work: Inspectors are stationed at ports of entry to inspect animal byproducts, hay, straw, etc., examine accompanying certificates, and exercise supervision and control over the disposition of imported materials. All such products are held by Customs for action by our inspectors, who indicate whether they may be released, must be subjected to quarantine or destruction, or may proceed to approved establishments where they will be disinfected in process of manufacture. During the fiscal year 1940, supervision was exercised over the transportation to, and handling at destination establishments of, over 20,000,000 hides and skins, as well as other animal byproducts permitted entry from countries where foot-and-mouth disease or rinderpest is known to exist. A most important duty is to prevent the landing of any chilled or frozen fresh meats whether sea stores or cargo, originating in countries where foot-and-mouth disease or rinderpest exists, which are prohibited entry under the tariff law. Measures are also taken to prevent the landing of garbage derived from such meats.

Project 7. Inspection and Testing of Animals for Export:

Objective: To protect and promote foreign trade in livestock through preventing the exportation of any animals that have been exposed to any communicable disease and by providing for their safe transportation.

The Problem and Significance: The law provides that freedom from disease of domestic ruminants and swine intended for export must be established and that vessels on which they are to be transported must be so equipped as to insure the safe and humane handling of the animals in transit. Any additional requirements of the receiving countries must also be met.

Plan of Work: Inspection service is regularly furnished at 18 ports, in addition to the inspection and testing of the animals in the various districts of origin throughout the country. During the fiscal year ending June 30, 1940, 16,975 animals were inspected prior to their exportation.

(h) MEAT INSPECTION

Appropriation Act, 1941	$5,433,000
Transferred in 1942 estimates to "Salaries and Expenses, Office of the Solicitor"	- 3,180
Total available, 1941	5,429,820
Budget estimate, 1942	5,429,820

PROJECT STATEMENT

Project	1940	1941 (Estimated)	1942 (Estimated)
1. Meat inspection operations at packing plants under the Federal Meat Inspection Service	$5,258,998	$5,284,125	$5,284,125
2. Determination of adulterations and other objectionable conditions in meat and meat food products by laboratory analysis	82,555	88,600	88,600
3. Inspection of imported meats and meat food products	29,982	29,775	29,775
4. Chemical, pathological, and zoological investigations relating to meat inspection	25,922	27,320	27,320
Total obligations	5,397,457	5,429,820	5,429,820
Transferred to "Animal Husbandry", Bureau of Animal Industry	+ 10,000	- -	- -
Transferred to "Diseases of Animals", Bureau of Animal Industry	+ 1,250	- -	- -
Transferred to "Salaries and Expenses, Office of the Solicitor"	+ 3,190	- -	- -
Unobligated balance	21,103		
Total appropriation	5,433,000	5,429,820	5,429,820

WORK UNDER THIS APPROPRIATION

General. Federal meat inspection has for its purpose the prevention, through the enforcement of the Meat Inspection Acts, of the use in interstate or foreign commerce of meat and meat food products which are unsound, unhealthful, unwholesome, or otherwise unfit for human food. The principal meat inspection operations at meat packing establishments include ante-mortem and post-mortem inspections of cattle, sheep, swine, goats, and, to a limited degree, of horses; reinspection of meat and meat products during processing, preparation, and packing; and the supervision of marking and branding of products to insure truthful labeling. In addition, the

service includes inspection under the Import Meat Act and Meat Inspection Acts of imported meat and meat food products; laboratory examinations as assurance against adulterations or similarly objectionable conditions, and determination of the character and importance of abnormal conditions in food animals encountered in ante-mortem and post-mortem inspections and subsequent inspections of meat and meat food products derived therefrom.

Project 1. Meat Inspection Operations at Packing Plants under the Federal Meat Inspection Service:

Objective: To effect rigid ante-mortem and post-mortem inspections of cattle, sheep, swine, goats, and horses slaughtered in inspected establishments to detect diseases or conditions which render any of the meat, organs, or parts unfit for food purposes; enforcement of sanitary requirements; reinspection of meat and products throughout the stages of the processing, preparing, and packing operations, and the inspection of ingredients, spices, and other substances added to meat and meat food products; custody, including supervision of the destruction for food purposes, of all condemned animals, carcasses, parts thereof, and meat food products; supervision of the labeling and marking of meat and meat food products; and investigation of the interstate transportation, by common carrier and otherwise, to ascertain compliance with the law as to eligibility of the product for interstate shipment and proper certification.

The Problem and Its Significance: For efficient results, each animal must be inspected before slaughter and each carcass, including organs and parts thereof, must be carefully examined at the time of slaughter. Approximately 7.78 percent of all animals slaughtered are affected with some degree of abnormalcy, which is seldom obvious except on close scrutiny. Accordingly, the constant presence of inspectors and their careful examination in every detail are required during slaughtering operations.

Meat and meat food products are perishable. Accordingly, reinspections requiring the regular presence and careful observation of inspectors are necessary throughout the stages of processing, preparing, and packing of such products. The ingredients, spices and other substances added to meat and to meat product must be carefully scrutinized as to their wholesomeness and proper use. Condemned animals, carcasses and parts, and meat food products must be destroyed under strict supervision and the passed articles must be truthfully and informatively labeled. Observations and investigations of the activities of common carriers of meat and meat product are necessary from time to time to see that only product of appropriate eligibility is shipped interstate.

The volume of operations is illustrated in the following tabulation, which it is expected will be equaled or exceeded in 1942.

Items	Fiscal years 1939	1940
Number inspected establishments.........	684	681
Number of cities at which establishments are located	249	263
Animals slaughtered	71,117,699	78,751,349
Animals condenmed.......................	25,749	27,236
Carcasses condemned.....................	202,793	223,543
Parts condemned	763,020	878,396
Pounds of meat processed................	8,440,446,161	9,690,165,254
Pounds of product condemned	5,338,945	5,031,327

Plan of Work. Under the Meat Inspection Acts, determination must be made by rigid inspections that each carcass, organ, part, and the meat food product prepared therefrom are free from unwholesomeness; that spices, condiments, and various ingredients are clean and fit; that meat food products are prepared in sanitary surroundings; that packages used are clean and satisfactory; and that labeling is truthful and informative. The inspection consists of physical examination of the meat and product, supplemented by chemical, bacteriological, and other technical observations for purity and check-weighing of products for accuracy of weight statements.

Project 2. Determination of Adulterations and Other Objectionable Conditions in Meat and Meat Food Products by Laboratory Analysis:

Objective: To determine by chemical analysis whether there has been added to or developed in meat food product substances of a kind not detectable by physical means, which result in adulteration or other objectionable condition and to determine purity and acceptability of such materials as water, ice, artificial colors, etc.

The Problem and Its Significance: Through careful observation over a period of many years, inspectors and laboratory directors have determined the relative frequency of chemical examination of various products necessary to avoid material deviations by meat processors from the requirements. The personnel employed and volume of work conducted are indicated in the following table:

Number of laboratories	Number of employees	Number of samples examined during year ended June 30, 1940	Number of samples found unsatisfactory
7	31	33,894	3,304

Plan of Work: Employees engaged in regular meat inspection work at official establishments and ports of entry, and those who supervise establishments operating under market inspection, or who investigate ship-

ments made by exempted establishments and farmers, procure, as occasion requires, and submit to the regional laboratories, samples of product for determination of their chemical and bacteriological compliance with the Meat Inspection Acts and regulations.

Project 3. Inspection of Imported Meats and Meat Food Products:

Objective: To determine eligibility of meat and meat food product for admission into the United States, and to determine wholesomeness and compliance with labeling requirements and other requirements concerning foreign meat and meat food products offered for importation.

The Problem and Its Significance: Under the Import Meat Act and the Meat Inspection Acts, meat and meat food product from countries having a national system of inspection which, as determined by the Secretary of Agriculture, is the substantial equivalent of the system maintained in the United States may be offered for entry. However, each consignment is carefully inspected to see that only meat and meat food product are accepted for importation which have been properly certified from abroad, are sound, healthful, wholesome, and otherwise fit for food, and are truthfully labeled. During the fiscal year ended June 30, 1940, there were offered for importation 116,758,965 pounds of meat and meat food product, of which 322,303 pounds were condemned or refused entry because of unsoundness, improper certification, improper labeling, etc. The work of this project is correlated to a large degree with that of Project 1 and requires in aggregate a service the equivalent of about 15 full-time employees.

Plan of Work: The plan of work is not subject to much change from year to year and is adequately illustrated in the paragraph entitled "The Problem and Its Significance".

Project 4. Chemical, Pathological, and Zoological Investigations Relating to Meat Inspection:

Objective: To establish definite diagnoses of pathological (diseased), parasitic and other conditions encountered by inspectors in the course of Federal meat inspection in order that proper determination may be made as to the fitness for human consumption of carcasses and parts of carcasses.

The Problem and Its Significance: (1) Not all pathological conditions are typical. Therefore, to be assured that proper diagnoses and dispositions are made in ante-mortem and post-mortem inspections in such cases, it is necessary frequently to submit specimens of tissue for laboratory examination. For example, tumors may not on the gross specimen show sufficient typical characteristics to enable the inspector to reach a specific diagnosis and, as a result, he must seek laboratory assistance.

(2) Parasites which infect to a degree the tissues of animal bodies, such as trichinae and cysticerci, require certain established treatments of the carcasses and tissues to meet the requirements of

the regulations. These treatments consist of heating, refrigerating, or special curing processes. The meat industry, due to more or less consistent changes in processing procedures, such as utilization of improved refrigerating methods, renders it necessary from time to time for the Department to investigate the efficacy of procedures offered by the industry for devitalization of trichinae and, to a lesser degree, perhaps, similarly investigate methods involved in the refrigeration of beef carcasses known to be affected to a limited degree with cysticerci.

Plan of Work: A large variety of specimens are submitted to the various pathological laboratories of this Bureau each year for diagnoses by technical employees. This enables veterinarians throughout the meat inspection service to inform themselves by comparison of the laboratory report with the gross evidences concerning unusual conditions met in meat inspection and further serves to unify the activities of veterinarians, especially those newer in the service in their differential diagnoses of various pathological conditions met in meat inspection work.

During the fiscal year 1940, specimens of arthritis in swine were submitted from a number of meat inspection stations in different parts of the country for study. It was found that a majority of these cases of arthritis were due to swine erysipelas infection and that the highest incidence of this infection was in hogs originating in the Corn Belt. This information is valuable not only in meat inspection but provides the Department with certain information of value to hog producers and to Department and other veterinarians dealing with livestock diseases at their source. A continued study of the conditions known as soft or mushy hams was made and information developed which indicates that tissues affected with sarcosporidiosis infestation results in so-called mushy hams much more frequently when the product is prepared at temperatures and under conditions recently adopted in the preparation of tenderized hams. Studies on tuberculosis of sheep were continued and, at least in one case, it was determined that sheep as well as swine may be affected with the avian type of tuberculosis.

The existing meat inspection requirements with reference to processing of pork and refrigeration of beef to destroy the vitality of parasites transmissible to man are based on investigations carried out some years ago under this appropriation. To keep pace with changing conditions in the meat packing industry, studies must be continued on the devitalization of trichinae by the various processes authorized and especially by proposed modification of such processes. In studies on devitalization of trichinae by heat, refrigeration, or other process, infected pork and pork food products containing trichinae are subjected to processing as proposed by the meat industry. Following the processing the products are examined microscopically and by the digestion technique to ascertain by direct examination whether the trichinae are dead or alive; and, finally, portions of these products are fed to rats or other experimental animals to determine whether or not infection results. More or less similar procedures are used in studies of cysticerci.

From time to time problems concerning biochemic and nutritive changes in animals or their tissues arise which can only be handled by laboratory means to determine the extent to which bacteria or mold action (or the presence or absence of bacterial or parasitic organisms) are involved. When it is suspected that conditions of feeding or management are responsible for abnormal-appearing conditions found in meat or its products, the studies are carried back to animals produced and handled under similar conditions to that represented by the meat to determine the cause of such changes and their real significance. Where meat packing procedures are believed to be involved, investigation of their effects is also made.

Project 5. Meat Inspection Operations for Other Government Agencies:

The services of employees in meat inspection, located at approximately 250 cities and towns throughout the United States, are used as required in inspection and examination of meats and other food products offered for delivery under various specifications by contractors to other Government agencies.

(i) VIRUS-SERUM-TOXIN ACT

Appropriation Act, 1941................$218,712
Budget estimate, 1942.................. 218,712

PROJECT STATEMENT

Project	1940	1941 (Estimated)	1942 (Estimated)
Control of manufacture, importation, and shipment of viruses, serums, toxins, etc...	$216,252	$218,712	$218,712
Unobligated balance........................	2,460	- -	- -
Total............................	218,712	218,712	218,712

WORK UNDER THIS APPROPRIATION

General. This appropriation covers the enforcement of the provisions of the Virus-Serum-Toxin Act approved March 4, 1913, regulating the sale, barter, exchange, and shipment of viruses, serums, toxins, and analogous products intended for use in the treatment of domestic animals, the importation of such products, and the importation and interstate movement of organisms or vectors that may introduce or disseminate diseases of animals.

Objective: To insure that all veterinary biologics produced by licensees are, in fact, not worthless, contaminated, dangerous, or harmful, and to prevent, insofar as possible, the interstate movement or importation of any veterinary biologic product, organism, or vector that is worthless, contaminated, dangerous, or harmful.

The Problem: To supervise operations in 74 establishments producing 91 different veterinary biologics in such a manner that will insure that all products produced by them are, in fact, pure and potent, and otherwise satisfactory for marketing. To effectively check and sample interstate shipments of veterinary biologics to determine whether any unlicensed products are included and whether these shipments include any products that are worthless, contaminated, dangerous, or harmful.

Significance: Biological products that are not properly prepared and tested may be worthless, contaminated, dangerous, or harmful to animals treated therewith. They may either fail to prevent or control an outbreak of disease and may even be the means of spreading disease. A license issued by the Secretary should carry with it reasonable assurance to the livestock producer that the products when properly used will afford protection and not be harmful to his animals. A biologic that is contaminated or otherwise improperly prepared, not only may endanger the herd that is treated, but may prove disastrous to other herds in the community through failure of the product in some respect.

Plan of Work: This entails the detailing of sufficient inspectors to the establishments producing anti-hog-cholera serum and hog-cholera virus so that all operations connected with the production and testing of these products are carried out under direct supervision. Inspection of plants producing biological products other than anti-hog-cholera serum and hog-cholera virus is made at infrequent intervals or upon instructions for special reasons.

(j) MARKETING AGREEMENTS WITH RESPECT TO HOG-CHOLERA VIRUS AND SERUM

Appropriation Act, 1941......................$30,000 (a)
Budget estimate, 1942....................... 30,000 (a)

(a) Transferred and payable from the unobligated balance of the appropriation provided by section 12(a), Title I, of the Agricultural Adjustment Act of May 12, 1933.

PROJECT STATEMENT

Project	1940	1941 (Estimated)	1942 (Estimated)
Marketing agreements with respect to hog cholera virus and serum...............	$29,795	$30,000	$30,000

WORK UNDER THIS APPROPRIATION

Objective: To insure that the Control Agency and handlers of anti-hog-cholera virus observe the provisions of the marketing agreement and order.

The Problem: The marketing agreement and order are applicable to 173 handlers of anti-hog-cholera serum and hog-cholera virus located at many different points throughout the United States. The marketing agreement is enforced by a Control Agency selected by the Secretary and handlers, whose acts are subject to review by the Secretary and his representatives.

Significance: The Serum and Virus Law of August 24, 1935, and Marketing Agreement of December 7, 1936, stress the economic importance of producers and other handlers maintaining an adequate supply of serum and virus at all times and aims to prevent undue and excessive fluctuations of prices, unfair methods of competition, and unfair trade practices.

Plan of Work: The work relates mainly to reviewing acts of the Control Agency, attendance at meetings, and the assembling of economic data relating to the production, sales, and prices of anti-hog-cholera serum and hog-cholera virus. Proposed amendments to the agreement and order have entailed conferences and public hearing for the purpose of receiving testimony and affording all interested parties the opportunity to file briefs.

(k) ERADICATION OF FOOT-AND-MOUTH AND OTHER CONTAGIOUS DISEASES OF ANIMALS

This item continues the availability of the unexpended balance ($1,318,219) of the appropriation of $3,500,000 made in 1924 to be used in case of an emergency arising from an outbreak of foot-and-mouth or other contagious diseases of animals. It provides also that $5,000 of this balance may, if needed, be used for the control of European fowl pest and similar diseases in poultry. No expenditures are contemplated during the fiscal year 1941 unless an emergency arises, but the availability of this fund is absolutely essential to insure immediate protection of the American livestock industry should outbreaks occur.

SUPPLEMENTAL FUNDS

Direct Allotments

Projects	Obligated, 1940	Estimated obligations, 1941	Estimated obligations, 1942
Special Research Fund, Department of Agriculture:			
Special research projects...........	$90,085	$89,460	$46,760
Special research laboratories in major agricultural regions.....	261,787	267,000	267,000
Total, Special Research Fund....	351,872	356,460	313,760
Agricultural Adjustment Administration (Salaries and Expenses): Marketing agreements, hog-cholera virus and serum............................	29,795	30,000	30,000
Total, supplemental funds..........	381,667	386,460	343,760

PASSENGER-CARRYING VEHICLES

The authorization for the purchase of passenger-carrying vehicles for the Bureau of Animal Industry contemplates an increase of $9,675 ($100,000 in 1941; $109,675 for 1942) in order to permit the Bureau to replace 217 old vehicles at an average cost of $506 each after exchange allowances are deducted. This is about 27 percent of the Bureau's cars. Of the 800 Bureau passenger-carrying vehicles now in operation, nearly 95 percent are used in inspectional work on farms in the rural districts, and many of them have mileage of 18,000 and upward a year. It has been the Bureau experience that cars assigned to rural inspectional work receive such rough use on secondary and county roads and lanes leading to farms that they must be replaced on an average at least every three years in order to keep mileage charges at the lowest possible point and to prevent frequent interruptions to the work which occur due to breakdowns when badly worn equipment is kept in service. All the cars to be replaced have reached the point where they can no longer be operated economically, the average mileage being over 40,000 and in individual cases running as high as 60,000.

The Bureau is unable to carry on economically and efficiently its varied activities in the field by the use of public transportation. Therefore, when government-owned cars are not available, it is necessary to authorize employees to operate their privately-owned cars on a mileage basis. The Bureau has found that the use of government-owned passenger-carrying vehicles for transporting its employees is considerably less expensive than when reimbursement is made to employees for the use of their own cars. The Bureau has found that government-owned passenger-carrying cars can be operated in almost every section of the country for approximately 3 cents a mile. This estimate is based on purchase price and operation charges, less trade-in allowance.

BUREAU OF DAIRY INDUSTRY

(a) GENERAL ADMINISTRATIVE EXPENSES

Appropriation Act, 1941	$75,500
Transferred in 1941 to "U. S. Official Mail and Messenger Service, Post Office Department", pursuant to the Reorganization Act of 1939 and Reorganization Plan No. IV	-100
Net available, 1941	75,400
Budget estimate, 1942	75,400

PROJECT STATEMENT

Project	1940	1941 (estimated)	1942 (estimated)
General administration and business service	$75,450	$75,400	$75,400
Unobligated balance	50	---	---
Total appropriation	75,500	75,400	75,400

WORK UNDER THIS APPROPRIATION

General. The work conducted under this appropriation includes the direction of the research, regulatory and business activities of the Bureau of Dairy Industry; general supervision of personnel, administrative review of publications and of material for disseminating the results of the research work, and the compilation of bibliographies of dairy literature and related library work.

Objective: The purpose of this activity is to assure maximum efficiency and effectiveness of the work of the Bureau, and to maintain central control over personnel, purchases, property, accounts, and other administrative procedures.

The Problem and Its Significance: The work of the Bureau of Dairy Industry is primarily research, dealing with all phases of the dairy industry. To assure a high degree of efficiency in the administrative activities and the proper coordination of the research program, central supervision and review is imperative. It is necessary that the research projects be provided with the funds and facilities required for the effective prosecution of their activities and that in providing such funds and facilities the requirements of laws and of the regulations of the Department be rigidly observed.

Plan and Progress of Work: In approving research projects consideration is given the availability of funds, personnel, and other requirements, and whether the anticipated results will constitute a real contribution to the dairy industry and will justify the expenditure involved. The work of research projects is reviewed from time to time to ascertain whether the plan of approach is correct and whether satisfactory progress is being made. The results of research work, both preliminary and final, are reviewed as to their scientific accuracy. The progress of the research phases of the Bureau's work is set forth under the head of "Dairy Investigations."

The fiscal, personnel, purchasing, and related so-called business activities of the Bureau are designed to service the research projects and to relieve the research workers of administrative detail but at the same time to see that the laws and regulations applicable to all matters of administration are rigidly followed. For example, procedures have been evolved whereby current and complete control of the administrative activities of field stations is effected without retarding the orderly prosecution of their research activities. In the conduct of the research work of the Bureau approximately three million pounds of milk are annually produced. While a considerable portion of this milk is used for experimental purposes, a very large amount is surplus. Most of the products into which milk is converted, such as butter and cheese, also become surplus and must be disposed of in accordance with regulations and to the best advantage to the Government. A system of accounting for all milk and products produced is maintained, through which the unauthorized use and disposal of products is prevented and maximum returns from surplus products are assured. Approximately $50,000 annually, or in excess of 6 percent of the total amount appropriated for the work of the Bureau, is received from sales of milk, cream, and dairy products. This money is deposited to the credit of miscellaneous receipts.

(b) DAIRY INVESTIGATIONS

Appropriation Act, 1941	$655,905
Budget Estimate, 1942	655,905

PROJECT STATEMENT

Projects	1940	1941 (estimated)	1942 (estimated)
1. Investigations of milk and butterfat production of dairy cows:			
(a) Investigations of inheritance of milk and butterfat production	$176,688	$179,385	$179,385
(b) Investigations of influence of feeding and management on level and cost of milk production and growth..	75,091	75,972	75,972
(c) Investigations of relation of conformation to producing ability	14,846	15,114	15,114
(d) Investigations of nutritional and other physiological factors affecting the usefulness of dairy cows	86,280	85,713	85,713
(e) Studies of dairy-herd-improvement association records to determine the effect of the application of breeding and feeding practices on level and economy of production	101,766	103,861	103,861
Total, Investigations of milk and butter fat production of dairy cows	454,671	460,045	460,045
2. Market-milk investigations:			
(a) Dairy sanitation research	9,203	11,800	11,800
(b) Milk-plant management investigations	6,135	7,870	7,870
(c) Milk quality improvement investigations	10,373	12,400	12,400
Total, Market-milk investigations	25,711	32,070	32,070

Projects	1940	1941 (estimated)	1942 (estimated)
3. Investigations of the utilization of milk in the manufacture of milk products:			
(a) Basic investigations of the bacteriology and chemistry of milk	$15,886	$15,750	$15,750
(b) General investigations of ice cream manufacture	16,888	17,058	17,058
(c) General investigations of the manufacture of butter and byproducts	43,618	43,932	43,932
(d) Condensed, evaporated, and dried milk investigations	18,633	19,796	19,796
(e) General investigations of cheese manufacture	29,872	30,844	30,844
(f) State and industry relations for milk products manufacture	29,928	29,410	29,410
(g) Enforcement of renovated butter act (regulatory)	6,607	7,000	7,000
Total, Investigations of the utilization of milk in the manufacture of milk products...	161,432	163,790	163,790
Unobligated balance	4,091	---	---
Total appropriation	645,905	655,905	655,905

WORK UNDER THIS APPROPRIATION

General. The work under this appropriation is designed to increase the milk and butterfat producing efficiency of the Nation's dairy cows; to improve the quality of products made from milk; to effect greater efficiency in manufacturing methods; to develop new products which may increase the markets for milk and provide for the more efficient utilization of milk byproducts; to investigate the sanitary production, transportation, processing, and distribution of market milk and cream, and to enforce the renovated butter act. These activities are conducted under the following projects.

Project 1. Investigations of Milk and Butterfat Production of Dairy Cows:

Objective: To improve methods of breeding, feeding, pasturing, housing, managing, testing, and judging dairy cattle, in order to increase the efficiency of dairy farming and make it a more profitable enterprise; to devise means for maintaining the health and vigor of dairy herds.

The Problem and Its Significance: There are about 25 million cows in the United States kept for milking purposes. The average butterfat production of these cows is 179 pounds a year. It is estimated that only one-third of the Nation's dairy cows are actually returning a profit to their owners; one-third are returning no profit, and one-third are actually being kept at a loss. The problem is to discover methods of selecting and breeding whereby 90 percent or more of the animals raised for dairy purposes would possess an inheritance for profitable production when properly fed and managed, thus removing the burden of raising large numbers of animals whose inheritance is such as to preclude the possibility of their ever being profitable producers no matter how well they may be fed.

The feeding of this national dairy herd is a matter about which there is much to learn. It must be fed in a manner that will insure the maintenance of the health of the animals, that the milk and butterfat produced will contain a maximum of nutritive and health-giving properties, and that the herd will produce profitably and at a low consumer cost. It is, of course, realized that, if the producing capacity of the Nation's 25 million dairy cows were suddenly raised to high levels, there would be an unprofitable surplus of milk. Even though improved practices were immediately accepted by dairy farmers and breeders (and this is considered unlikely because innovations are adopted gradually), it would require years to produce the number of bulls possessing the inheritance for transmitting producing ability necessary to insure an increase in the production level of the national dairy herd. It is the purpose of this work to determine the principles governing the transmission of high milk and butterfat-producing ability and to demonstrate to dairy farmers how to perpetuate producing inheritance in their herds and thus reduce to a minimum the number of animals that will be raised only to be discarded later when it is found that they do not possess an inheritance that will enable them to be good producers. The research is also directed toward finding more economical methods of feeding for milk production, in order to demonstrate that, although some methods of feeding actually lower the production of good cows, at the same time they are more economical than the commonly accepted feeding methods because of their lower cost. This latter work will, it is believed, also provide a basis for adjusting milk production to consumer demand even though more efficient production is obtained through better breeding practices.

The annual farm value of dairy products normally is in excess of two billion dollars, and the gross income from dairy products is from 20 to 25 percent of the total income from all farm products. Although the money value of the dairy industry compares favorably with that of great industrial enterprises, its individual units are small and are under the ownership and direction of a large number of people. This divided ownership makes it impossible for the industry itself to conduct research for its advancement and guidance, as is the case with other great industries under more centralized control. Yet, it is an industry that affects the livelihood of so many people from the standpoint of nutrition and health, and one which bears so strong a relationship to the maintenance of our soil fertility that its advancement and welfare is a matter of national importance.

Plan and Progress of Work: The procedure, followed in carrying out these investigations is discussed under the various work projects, which follow.

(a) "Investigations of inheritance of milk and butterfat production." The purpose of this project is to determine the comparative effects of different methods of breeding in fixing an inheritance for high and uniform levels of producing ability in dairy cows. In general, this problem has been attacked by actual breeding experiments with dairy cattle. The method of breeding that appears to be giving the most definite, favorable results, with a minimum of undesirable features, is the use of meritoriously proved sires for generation after generation. A meritoriously proved sire is one that by actual breeding tests has shown that he possesses an inheritance that enables him to transmit to all of his offspring the hereditary factors governing level of production that will make it possible for them to be uniformly high producers. That progress is being made by this method of breeding is indicated by the percentage of sons of proved sires that are able to improve production in the farmers' herds where they are placed. For example, production data on the daughters of 159 sons of meritoriously proved sires show that 87 percent of them, or almost 9 out of 10, raised the level of production in the herds in which they were used.

(b) "Investigations of influence of feeding and management on level and cost of milk production and growth." Since feed costs usually represent more than half the total cost of keeping a dairy cow, work under this project has been directed largely toward the development of methods of feeding that will reduce the cost of feeds per unit of milk and butterfat produced. Investigations have shown that digestible nutrients may be produced in roughages at approximately half the cost of their production in grain crops, and that cows fed all of the high-quality roughage they would consume and half of the usual full-grain ration would produce approximately 85 to 90 percent as much milk as when fed a full-grain ration. When fed entirely on high-quality roughage, production was from 65 to 70 percent as much as when a full-grain ration was fed. These findings indicate methods by which dairymen might profitably control surplus production and at the same time aid in soil conservation and improve soil fertility. One of the drawbacks to the plan of having roughages provide the source of a higher percentage of the nutrients in the dairy cow's ration was the inability to produce high-class roughage due to unfavorable weather conditions that were likely to occur during the hay harvest season. Experiments have been under way to effect methods whereby high-quality roughages could be preserved economically even when unfavorable weather conditions prevailed. These experiments have been along the lines of artificial drying of hay and the ensiling of grasses and legumes. The latter method can be followed with less expensive equipment, although the losses of dry matter in the ensiling process have often been high. To overcome these losses investigators have recommended the use of preservatives such as acids and molasses. The Bureau's investigations have shown that these preservatives do not have to be used if the green material is wilted before ensiling and if the material is finely cut and thoroughly packed in order to exclude the air. The practice of

ensiling grasses and legumes is increasing rapidly. It is estimated that about a million tons were ensiled in 1939.

(c) "Investigations of relation of conformation to producing ability." The fact that only approximately five percent of the dairy cows in this country have definite individual production records indicates that the great bulk of the selection of dairy cattle, both for breeding purposes and for purchase, is made on the basis of the type or appearance of the animal. Considerable emphasis has been given the correct dairy cattle type in high school and agricultural college courses and at fairs and livestock shows. What constitutes correct type appears to be a matter of opinion based on observation rather than on scientific facts. Recognizing that a scientific basis should underlie a practice used so extensively and one that may be so vital to the economic success of so many individuals in the industry, an investigation was undertaken in an attempt to determine the relationship of conformation to producing ability. Cows in the experimental breeding herd at the Beltsville Research Center that made records under carefully-controlled environmental conditions were measured for outward development, and when their usefulness for the breeding experiments was at an end they were slaughtered and measurements and weights of the internal organs were secured. A number of State colleges and experiment stations have been cooperating in securing similar data. These ante-mortem and post-mortem data have now been secured on 729 cows with production records. These cows include representatives of most of the dairy breeds. Although there are not sufficient data available from which any definite and authoritative determinations may be made concerning the general problem of relationship between conformation and producing ability, the studies have produced many byproduct results of value to dairymen. For example, it has been determined that milk secretion is a continuous process and that there is no basis for the time-worn theory that it is secreted only at the time of milking. This finding led to an experiment to determine whether "stripping" was as important as has been taught. The results showed that cows which retained almost two pounds of milk in the udder at each milking produced practically as much as cows that were "stripped". Another important discovery was that cancer, a disease of high incidence in the mammary glands of humans and many species of domestic animals, is almost non-existent in the udders of dairy cows. In 418 udders of cows of all ages that were sectioned no growths or tissue changes that appeared to be of a cancerous nature were found.

Results of studies of the mammary development of a large number of heifer calves in the Beltsville herd give a rather favorable outlook for the development of a method for the selection of heifers at an early age that would be low producers if allowed to mature. Such a method would be of inestimable value to dairymen in that it would relieve them of the losses which otherwise would be incurred in raising to maturity heifer calves that should have been discarded as soon as their inferiority was established.

(d) "Investigations of the nutritional and other physiological factors affecting the usefulness of dairy cattle." To feed dairy cattle efficiently from an economic standpoint it is essential to have facts

based on scientific research concerning the nutritional requirements of the animals and the amount of each nutrient required and of the feeds which under varying conditions should be fed in order to supply the required nutrients. In order to obtain this fundamental information, studies must be made of the known nutrients, supplemented by investigations to discover unknown factors which may materially affect the efficiency of feeding practices. The effect of nutrients on growth, reproduction, health, yield, and composition of milk and the span of the productive life of the animal must be known. The work under this project is designed to supply this information.

The work on the vitamin-A requirements of dairy cattle is illustrative of the type and practical application of the work performed. Cows that were fed continuously on rations containing low-grade alfalfa or timothy hays as their only roughage were found to produce abnormal calves. Calves were born dead or blind or so weak that they soon died. This condition was shown to be due to a deficiency in the vitamin-A potency of the hays. This deficiency was also shown to affect the nutritive value of the milk. The amount of vitamin A from plant sources that must be fed cows to prevent these abnormal calvings was determined, as were the feeds or supplements that could be used to supply the vitamin-A requirement. Some alfalfa hays were found to be more than 100 times as potent a source of vitamin A as others; some timothy hays, 36 times as potent as others; and some corn silage as much as 40 times as potent as others. The vitamin-A potency of the hays was shown to vary with their color and market grade; consequently the dairyman may be guided in his feeding practices by proper selection of hays. The nutritive value of the milk was shown to vary more than 3-or 4-fold, depending upon the feeds used. This work was extended to include a study of the vitamin-A requirements of calves, the results of which showed that it is unnecessary to feed whole milk to calves. Instead, skim milk may be fed, provided it is supplemented with adequate amounts of vitamin A in the form of carrots or cod-liver oil. Generous amounts of vitamin A in the diet were found to reduce the losses of very young calves. The work on vitamin A under this project has been of practical value not only in correcting reproductive failures with cows fed poor-quality hays as their only source of vitamin A, but also in drought areas and regions where cows get very little good pasture and feed largely on dried stubble which has lost its vitamin-A potency.

In like manner work on the calcium and phosphorus requirements of dairy cattle has been and is being conducted under this project. The results, which have been confirmed by other investigators, show that erroneous conclusions were being drawn from short-time experiments, that these elements are much more efficiently used by milking cows than the results of the experiments indicated, and that frequently calcium and phosphorus supplements are unnecessary. This work has also shown that hays which are low in calcium, like timothy hay, contain enough of this element for optimum growth. Extensive work has been done under this project on the quantities of energy and protein that it is necessary to supply in the diet of milking cows and on the qualitative value of various feed proteins and the composition of milk proteins.

Long-time feeding experiments are in progress with cows on rations containing various types and grades of roughages, with and without pasture, to determine the effect of such rations on the health, reproduction, productiveness, and span of life. Some animals with certain rations have been reared for generations even without pasture; on other rations there have been failures in reproduction similar to those which occurred with a vitamin-A deficiency, whereas in other cases there is a tendency to sterility which may or may not be relieved by pasture feeding. The causes of these differences are being sought. The work is designed to learn the nutritional conditions essential to maintain dairy cattle at optimum usefulness.

(e) "Studies of dairy-herd-improvement association records to determine the effect of the application of breeding and feeding practices on level and economy of production." This project is discussed under three heads - (1) Proved-sire work, (2) bull association work, and (3) farm-management and dairy-production studies, as follows:

(1) Proved-sire work. -- There are 1,300 dairy-herd-improvement (cow-testing) associations operating in the 48 States, Puerto Rico, and Hawaii testing more than 676,000 cows in approximately 28,000 dairy herds. The feed and milk production records of cows in these herds are summarized and analyzed to show the value of milk produced, the feed cost, and the income over feed cost for each cow on test. With this detailed information the dairy farmer may intelligently discard low-producing, unprofitable cows from his herd and adopt better-feeding practices. The feed and production records are summarized and analyzed by herds, by associations, by States, and for the United States. These analyses are made available to the State colleges to be used by them in their extension programs to promote the adoption of improved dairy practices.

Improving dairy herds through culling, feeding, and management has definite limitations, as a cow cannot be made to produce more than her inherent or natural producing capacity. Genuine herd improvement, therefore, must come through breeding. Dairy farmers generally, however, are having discouraging and costly experiences in improving the breeding of their dairy cows. A farmer may be successful in selecting a bull that will improve his herd, but experience shows that two times out of three he will, if left to his own initiative, select a sire that will lower the average production of his herd.

To assist dairymen generally in selecting bulls that should improve their herds the production records obtained in dairy-herd-improvement associations are being used as the basis of a Nationwide sire-proving program. In a sense, 676,000 cows on test serve as a breeding herd to supply improved breeding stock for the 25,000,000 cows in the United States. To accomplish this purpose breeding stock, particularly sires, must be made available in large numbers. To place this far-reaching program into operation it is necessary to identify every animal on test, approximately 70 percent of which are grade animals and in the past have not been satisfactorily identified. A Nationwide eartag identification plan was developed through which every grade or non-registered animal is identified. With complete

identification records of grade as well as purebred animals, blood and family lines may be traced and evaluated in all herds in dairy-herd-improvement associations. Complete identification and production data for the 676,000 cows in association herds are being assembled by the Bureau of Dairy Industry. The data are used to indicate the breeding value of every sire used in every association herd. As the work progresses from year to year proved sires and the sons of proved sires will be identified and located. Already more than 6,000 sires have been proved and thousands of sons of proved sires have been identified. Eventually it should be possible to have several sires in every section on which data are available to indicate their breeding value. When this situation prevails the demand for improved breeding stock may be satisfactorily supplied.

To disseminate all available information on dairy sires, a proved-sire record for each sire is issued to the owner and to dairy leaders in the States. The genetic make-up of sires is indicated so that inferior ones may be discarded while superior ones may be retained for more extensive use. Complete genetic analyses are made of association herds to indicate those animals and families of animals that seem to possess the ability to transmit to their offspring an inheritance for high-producing capacity. The influence of the superior animals and families may then be perpetuated and disseminated throughout the dairy-cow population. At 6-month intervals the records of all proved sires are published for general distribution in order that information on proved dairy sires may be available to dairymen and dairy leaders generally.

(2) Bull association work. -- Cooperative dairy-cattle breeding association programs are sponsored and directed by the Bureau of Dairy Industry to demonstrate the advantages of an organized dairy-cattle breeding program for a community and the economy of cooperative ownership and use of herd sires. Bull associations and artificial dairy-cattle breeding associations provide the facilities for long and extensive use of good proved sires. Through these associations outstanding proved sires, regardless of their age, are usually more completely utilized and their influence more widely disseminated than would be possible through individual ownership.

(3) Farm-management and dairy-production studies. -- Oftentimes a dairyman will lose money on his farm business as a whole even though he has a high-producing dairy herd. In such cases financial records to supplement the feed and production records will show the weak and strong points in the organization and operation of the farm. It may be that the income from the dairy herd is being wasted by uneconomical feeding and care, paying extravagent prices for new stock and having only cull stock to sell, inefficient crop production methods, high expenses for buildings and equipment, etc. Recognizing that efficiency in farm organization and operation is necessary to obtain the greatest net farm income, complete financial records are now being obtained on many farms in dairy-herd-improvement associations. This phase of the project is conducted in cooperation with the Bureau of Agricultural Economics and records obtained are analyzed jointly by the two bureaus.

The results of the analyses of farm-management and dairy-production data are made available to the State colleges for use in promoting more profitable practices.

Project 2. Market-Milk Investigations:

Objective: To improve methods of producing, handling, processing, and distributing fluid milk and cream in order to increase their wholesomeness and palatability and to decrease costs of production and handling for the purpose of yielding greater returns to dairymen and increasing the consumption of milk through greater safety and attractiveness.

The Problem and Its Significance: Nearly half of the entire amount of milk produced in the United States annually is used in the fluid state for human consumption. Much of this milk is rejected by buyers or reaches the market in a condition that makes it either unsalable or salable only at a reduced price. Milk of low quality often has undesirable flavors and other disagreeable characteristics which prejudice consumers against its use. The loss to dairy farmers due to low-quality milk amounts to many millions of dollars annually. This loss can be avoided by applying the results of investigations conducted by the Bureau of Dairy Industry under this project. The work deals not only with farm conditions but with the various steps in handling milk from the farm to the consumer. Pure, wholesome milk is essential to proper nutrition and a decent standard of living. Formerly much disease, especially among infants, was caused by carelessly produced and handled milk. This has been largely eliminated through application of the results of research, but much work remains to be done in order to bring the milk supply of the Nation to a uniformly high level of quality.

Plan and Progress of Work: The market-milk work is conducted under the projects (a) Dairy sanitation research, (b) Milk-plant management investigations, and (3) Milk quality improvement, as follows:

(a) "Dairy sanitation research." The purposes of this project are to prevent losses due to souring, spoilage, and other causes; increase the market value of milk to the farmer; increase the consumption of milk; and insure the safety of rural and urban milk supplies.

This research is intended to discover basic faults in the production of market milk and to devise remedies which can be readily and economically applied. Considerable progress has been made on the effect of mastitis, an udder disease of dairy cows, on the physical and bacteriological properties of milk. A causal organism of an unusual type has been isolated and identified. Indications are that this type of infection is more widespread than is commonly realized. A new test for the detection of mastitis streptococci, which is both simple and accurate, has been devised. This work provides fundamental data for the inauguration of preventive measures and for the treatment of the disease.

Experiments in the pasteurization of goat's milk by both the holder and the short-time, high-temperature methods are practically complete. Results indicate that goat's milk can be readily pasteurized without serious impairment of either its chemical or nutritive properties.

Chlorine and alkali solutions, which are widely used for bactericidal treatment of dairy utensils, have been tested as to their corrosive effects on numerous metals commonly used in the dairy industry. As a result of these experiments, metals that can be safely used without serious deterioration by cleaning solutions can be recommended.

Short and accurate tests to determine the quality of milk are another phase of the research work under way. The commonly employed tests are time-consuming and in general not applicable to field use. Some promising results have been obtained in modifications of the phosphatase test to determine the efficiency of pasteurization.

(b) "Milk-plant-management investigations." The studies under this project are designed to effect economies in initial investments and operating costs of milk plants so as to reduce the "spread" between producer and consumer through greater efficiency in plant operation. They concern principally the methods used by the larger and more efficient plants, but the results are made available also to smaller plants which are without adequate facilities for research and efficiency studies. Indeed, the results of these studies have been particularly useful to the operators of small plants and to farmer's cooperative associations which operate plants either for cooling the milk of their members or for final processing for the consumer.

(c) "Milk quality improvement investigations." These investigations are intended to discover undesirable practices which impair the market qualities of milk and cream and to devise remedial measures.

The effects of certain feeds and weeds and of methods of feeding on the flavor and odor of milk have been studied, and methods of feeding and of handling milk have been devised which either avoid unpleasant flavors entirely or so reduce them that they are practically unnoticeable.

Experimental work with homogenized milk is nearly completed. As a result of this work the industry may be advised as to the proper methods of handling and processing milk in order to place on the market homogenized milk which is palatable and of pleasing appearance.

The idea that the curd tension of milk is associated with its digestibility has become rather popular, and studies have been made to ascertain whether there is any correlation between the two factors. Various methods of treating milk, as by homogenization, pasteurization, etc., have been tried out. Together with this, work has been conducted on the total curd surface of milk during artificial digestion. This work so far has indicated that the curd area or surface cannot always be correlated with the curd tension; but, on the average, as the curd

tension of milk is lowered the surface area of the curds increases. The practical effect of this particular problem is to show methods by which milk may be prepared for human consumption in a more easily digestible form.

Project 3. Investigations of the Utilization of Milk in the Manufacture of Milk Products:

Objective: To increase the returns to the producers of the milk by (1) increasing consumption by improvements in quality; (2) lowering the cost of manufacture through increased efficiency and reduction in the proportion of undergrade products, and (3) converting byproducts of milk into marketable form.

The Problem and Its Significance: Milk surpluses occur from time to time due to seasonal fluctuations in production and economic conditions. Because surplus milk has a demoralizing effect on the market, it is improtant to devise means for extending the markets for fluid milk and for getting it to the consumer more efficiently and economically through the application of newly developed methods of refrigeration, concentration, and sterilization.

It is possible to control quality in the manufacture of dairy products only through a knowledge of the bacteriological and chemical changes involved and the application of this knowledge to factory processes. This requires research to provide the basis for formulas and rules applicable to factory conditions. Defects in quality are usually the result of insufficient knowledge of the factors influencing flavor or texture and of the methods controlling these factors under commercial conditions.

One hundred and ten billion pounds of milk are produced annually in the United States, of which 45 billion pounds are used to make 2 billion pounds of butter valued at over $500,000,000. The mediocre quality of a large portion of this butter is responsible for low consumption and for the use of substitutes. This poor quality is due principally to the use of old fermented cream, a condition which can be corrected by increasing the uses for and value of skim milk to a point that would make it profitable for the farmer to ship whole milk to the factory and thus provide a supply of fresh sweet cream for butter making.

Seven billion pounds of milk are used annually in cheese making. The per capita consumption of cheese in this country is much below that of other countries, largely because of the inferior quality of the domestic product, which likewise accounts in large measure for the low prices received by farmers for milk to be made into cheese. As manufacturing defects are overcome or materially improved and better distribution methods are devised, the proportion of low-grade cheese which must be marketed at a very low price can be materially reduced, market demand increased, and factories enabled to pay higher prices for milk. An increased per capita consumption of one pound of cheese would provide an additional market for 1,300,000,000 pounds of milk per year.

About 43 percent of the 14 billion pounds of milk solids produced annually must be sold in the form of byproducts. For a pound of solids sold in this form the farmer receives less than one-tenth as much as he gets for a pound of milk solids for direct consumption. Obviously, the development of any method by which skim milk, whey, and buttermilk can be converted into products for which there is a ready market will be of direct benefit to the farmers.

Plan and Progress of Work: Researches on milk-manufacturing problems are covered by the following projects:

(a) "Basic investigations of the bacteriology and chemistry of milk." Work under this project includes studies of the composition of milk fat, with special reference to some of the minor glycerides which may be of significance in human nutrition; on the oxidation of fats in their relation to deterioration in the flavor of milk, cream, butter, milk powder, and other products; on the influence which bacteria may have on the growth of other bacteria when grown together; and the factors which influence the temperature at which bacterial spores are killed. While the work of this project is largely basic research in character, investigations of a fundamental nature frequently develop applications of commercial value. For example, a study of means of determining the hydrogen ion led to results which have been applied in a great variety of industries and without which many practical problems could not have been solved. An investigation into the factors which limited the fermentation of lactose by bacteria led to a large scale commercial enterprise for fermenting the milk sugar of whey in order to obtain lactic acid for industrial and food uses.

(b) "General investigations of ice cream manufacture." The mix from which ice cream is made is exceedingly complex from the physical-chemical standpoint, and is further complicated by the changes which occur as the solubility of various constituents is changed by the low temperatures of the freezing process. The ice cream industry has been developed largely by empirical methods, with little accurate knowledge of the scientific principles which control the texture, overrun, and other factors influencing the quality of the product. The investigations being conducted under this project are designed to establish a scientific basis for controlling the physical properties and through these the organolyptic characteristics of the ice cream. Improved methods of incorporating milk solids into ice cream resulted from these investigations. The discovery that the addition of cane sugar to milk decreased the viscosity and thus permitted the crystallization and separation of the lactose formed the basis for a method of increasing the milk-solids-not-fat without producing the sandy texture caused by the formation of crystals of lactose. In addition to providing a profitable use for a large volume of skim milk, in one factory where this procedure has been adopted the quality of the ice cream has been so improved that sales have increased 20 percent. Incidentally, a supply of lactose has been provided at a low production cost.

(c) "General investigations of the manufacture of butter and byproducts." While some work is being done on the control of oxidation

in storage butter, the main line of attack on the butter-quality problem is through the byproducts -- skim milk and buttermilk. About 50 billion pounds of skim milk and nearly 3 billion pounds of buttermilk are produced as byproducts of the country's butter-making industry. These byproducts contain approximately 450,000,000 pounds of sugar, proteins, salts, and vitamins, all in a suitable form for human nutrition. The problem is to convert them into more concentrated and more palatable products for which the consumer will pay enough to adequately cover the cost of production, processing, and distribution. Cottage cheese, developed commercially largely through the efforts of the Bureau of Dairy Industry as a wartime measure, utilizes 800,000,000 pounds of skim milk annually. Other cheeses are now being made experimentally with a view to further conserving the solids-not-fat of the milk for food purposes. Methods have been developed for using the solids of cheese whey in confectionery, in dried and canned soups, and in fruit whips. These methods are now coming into commercial use with prospects of a large consumption of whey, principally from the cheese factories which now sell whey for feeding purposes at as low as two cents a hundred pounds.

By combining skim milk or whey solids with other food materials, new products of high food value are obtained. A potato wafer, made by combining skim milk with cull potatoes, has been developed which will keep indefinitely and is suitable for shipping under unfavorable climatic conditions.

A method of fermenting the lactose of whey into lactic acid has been developed and established commercially. This fermentation is very efficient and in one plant the sugar in 180,000 pounds of whey is fermented into lactic acid every 24 hours. The increased production of lactic acid by this process has made it necessary to investigate additional uses for lactic acid. Two acrylate products have been developed which will have a wide application in industry; and a number of new lacquers and resins have been made, some of which have properties which make them of value in surfacing metals and wood.

The proteins of milk are more suited to conversion into plastic materials. A method for making a wool-like fiber from casein has also been perfected, and five public-service patents on different steps of the process have been obtained.

(d) "Condensed, evaporated, and dried milk investigations." The high cost of market milk in relation to the purchasing power of the consumer has increased the importance of the various methods of transporting and preserving milk in a concentrated form. The factor which limits the more extensive use of evaporated milk is the slight cooked flavor caused by the high temperature of sterilization. The high temperature is required to kill the very small proportion of highly resistant bacterial spores. Hence, it is necessary to investigate the factors influencing the thermal death point of the spore-forming bacteria, the conditions determining the changes in color and flavor in the sterilization of milk and cream, and the changes which take place in these products in sterilization.

Dried milk deteriorates through spontaneous chemical changes, chiefly oxidation of the fats and fat-like ingredients. The nature of these changes and the factors which accelerate or retard them must be determined and methods of manufacture and storage devised which will reduce the unfavorable effects to a minimum.

(e) "General investigations of cheese manufacture." Over 600,000,000 pounds of cheese of the American Cheddar type are made in this country annually, of which a large part is of inferior quality and is converted into process cheese. The plan of attack on the cheese problem is to determine by chemical, bacteriological, and pilot-plant manufacturing investigations the significant factors which establish the character of the cheese, followed by work in factories to demonstrate that the methods developed in the laboratory are applicable to commercial operations. The essential factors in the control of quality in Cheddar cheese have been established and are being demonstrated to the industry. One small factory, following the methods devised, is paying farmers 10 percent more for milk than neighboring factories. One large cooperative, making 10,000 pounds of cheese per day, attributes a 58 percent increase in sales in 7 years directly to improved quality obtained by applying the methods developed by the Bureau of Dairy Industry.

The distribution of cheese has been handicapped by the inconvenient and wasteful methods of manufacture and marketing. A successful method of ripening cheese in cans has been devised and is coming into commercial use.

This country normally imports about 60,000,000 pounds of cheese of various types each year. This cheese which commands much higher prices than domestic types could all be made here if the proper methods of manufacture, ripening, and use of microorganisms were established. This has been done for certain varieties, and, with the foreign supply cut off, their manufacture is being established. The most important of the foreign-type cheese (Swiss) is already made extensively in this country, but all factories at times produce a high percentage of under-grades. In some factories a high proportion of under-grades exists at all times. The peculiar characteristics of Swiss cheese are caused by a very complicated sequence of bacterial activities, and a long investigation has been necessary to determine the essential factors which must be controlled in the factory to insure a satisfactory proportion of high-grade cheese. This investigation is not yet complete.

Research is being conducted to develop new types of cheese which will utilize a larger proportion of the milk solids, thus reducing the economic waste resulting from the necessity of feeding whey to farm animals.

(f) "State and industry relations for milk products manufacture." In developing the application of results obtained in the laboratory to the industry, it is necessary to know what the problems of the industry are and to demonstrate to the industry the value of new methods and

of new products. This involves contact with State officials and manufacturers, cooperatives, and individuals.

Field men with mobile laboratories are maintained in Ohio and Wisconsin in cooperation with the State experiment stations to demonstrate the value of laboratory control of the manufacturing processes and the use of pure cultures of bacteria. In one large factory last season methods of operation were completely revised to conform to the principles of control recommended by the Bureau of Dairy Industry. The quality of the cheese made showed such a marked improvement that in July and August, the most difficult months of the year, the returns were increased over $1,000 per month.

In Wisconsin Cheddar cheese factories the Bureau is establishing simple methods which make it possible to produce a uniformly high-grade of cheese. This is combined with a demonstration of the proper methods of packing Cheddar cheese in cans.

(g) "Enforcement of renovated butter act (regulatory)." The manufacture of process or renovated butter is primarily a salvage proposition whereby butter which has so deteriorated that its salability as ordinary butter is practically destroyed is so processed and treated that it can still be sold as a food product. Marked progress has been made during the past few years in improving the quality of the raw material used by qualified renovated butter manufacturers through enforcement of more stringent regulations and through the maintenance of close contact with other Federal and State agencies. There is, however, need for a more rigid enforcement authority to properly and completely safeguard consumers in the matter of wholesomeness and purity of the finished product. With the idea of making constructive recommendations for strengthening the enforcement provisions of this law, a study is being made of all State and Federal laws pertaining to this product. Under this project the method of analyzing butter for extraneous material originated in the Bureau of Dairy Industry. This method, perfected and improved by the Food and Drug Administration, is now generally used by regulatory agencies throughout the United States to determine by a relatively simple test the presence of undesirable material in dairy products. Considerable progress has been made in the matter of improving the quality of the raw material and in the methods of processing and manufacturing. Assistance has been rendered the Bureau of Internal Revenue, Treasury Department, in supplying technical knowledge of legal and illegal methods in the manufacture of dairy products. In order to maintain closer contact with the producers, direct inspection of all qualified process or renovated butter factories have been effected under this project. The strict enforcement of the Renovated Butter Act as to sanitation, proper branding and marking, and prevention of fraud serves to protect the consumer and prevents this product from being manufactured or sold as regular creamery butter.

SUPPLEMENTAL FUNDS

Direct Allotments

Projects	Obligated, 1940	Estimated obligations, 1941	Estimated obligations, 1942
Special Research Fund, Department of Agriculture: For special dairy cattle and dairy products researches.	$57,046	$67,980	$60,000
Emergency Relief Appropriation Act of 1941:			
Coding, indexing, tabulating, checking, and completing a genealogical and production record of animals in the dairy-herd improvement program	---	11,346	---
Administrative expenses	---	412	---
Total, Supplemental funds (direct allotments)	57,046	79,738	60,000

BUREAU OF PLANT INDUSTRY

Proposed Regrouping of Subappropriations

The 1942 estimates provide for a regrouping of the subappropriation items of the Bureau of Plant Industry, reducing the number from 24 to 16. The revised number of items is designed primarily to simplify the appropriation set-up and to facilitate consideration of the estimates on a more logical and convenient basis. The amounts of money available to the discontinued subappropriation titles would be carried in the respective continued items of 1942, to insure continuation of the work. A statement will be presented to the Committee showing all of the transfers, consolidations, etc., that are involved in the proposed set-up.

Under the plan proposed in the estimates all soils research is set up under two major subappropriation headings-- (a) Soil and Fertilizer Investigations and (b) Soil Survey. The appropriation items for four lines of soil investigations would be consolidated under the proposed title "Soil and Fertilizer Investigations",to provide for a closer coordination and more effective attack on soil problems and soil-plant relationships. This new subappropriation item would absorb the soil-management work previously carried in the item "Soil-Fertility Investigations"; it would also absorb the former subappropriation items "Fertilizer Investigations", "Soil Microbiology Investigations", and "Soil Chemical and Physical Investigations". "Soil Survey" would remain as a separate subappropriation.

"Soil-Fertility Investigations" would be discontinued as a separate subappropriation item. The work done under this item would be allocated to four other subappropriations, that part of the work that is pertinent to the respective subappropriations being assigned to them. Cotton soil-fertility investigations and cotton root-rot soil and fertilizer investigations would be consolidated with "Cotton and Other Fiber Crops and Diseases"; citrus, pecan, and potato soil-fertility investigations and soil-fertility investigations on truck and miscellaneous crops with "Fruit and Vegetable Crops and Diseases"; soil management (soil improvement by crops and cropping methods) with "Soil and Fertilizer Investigations"; and sugarcane and sugar beet soil-fertility investigations with "Sugar-Plant Investigations".

"Experimental Greenhouse Maintenance" would be discontinued as a subappropriation item and become part of "Fruit and Vegetable Crops and Diseases", in connection with research work pertaining to these crops.

"Genetics and Biophysics" would be discontinued as a subappropriation item and become a part of "Cereal Crops and Diseases", since most of the research work in "Genetics and Biophysics" pertains to corn investigations.

"Botany" would be discontinued as a subappropriation item. Weed control investigations would become part of "Cereal Crops and Diseases", since the actual work on weeds has been done in the Division of Cereal Crops and Diseases. The work on wild plant improvement (blueberries, gooseberries, etc.) would become part of "Fruit and Vegetable Crops and Diseases", and economic herbarium maintenance and systematic botany studies would become part of "Plant Exploration, Introduction, and Surveys".

The title of the subappropriation "Plant Exploration and Introduction" would be changed to read "Plant Exploration, Introduction, and Surveys", to cover the inclusion of the economic herbarium maintenance and systematic botany studies from "Botany" and the former subappropriation items "Mycology and Disease Survey" and "Nematology". Work done by each of the latter subappropriations entails collections of materials, surveys, etc., and would be well covered under the proposed set-up.

BUREAU OF PLANT INDUSTRY

(a) GENERAL ADMINISTRATIVE EXPENSES

Appropriation Act, 1941 .... $209,942
Budget Estimate, 1942 209,942

PROJECT STATEMENT

Projects	1940	1941 (Estimated)	1942 (Estimated)
General administrative and business service	$209,807	$209,942	$209,942
Unobligated balance	135	- -	- -
Total appropriation	209,942	209,942	209,942

WORK UNDER THIS APPROPRIATION

This appropriation provides for the direction of the research and service work of the Bureau of Plant Industry, the administration of fiscal affairs, general supervision of personnel, and the administrative review and preparation of research and other publications, including bibliographical and related work.

(b) ARLINGTON FARM

Appropriation Act, 1941 .... $49,414
Budget Estimate, 1942 49,414

PROJECT STATEMENT

Projects	1940	1941 (Estimated)	1942 (Estimated)
Arlington Farm: Maintenance of facilities for basic plant research	$48,997	$49,414	$49,414
Unobligated balance	417	- -	- -
Total appropriation	49,414	49,414	49,414

CHANGES IN LANGUAGE

The estimates include proposed changes in the language of this item as follows:

For continuing the [necessary improvements to establish and maintain] maintenance of a general experiment farm and agricultural station on the Arlington estate, in the State of Virginia, and in the vicinity of Beltsville, Maryland, in accordance with the provisions of the Act of Congress approved April 18, 1900 (31 Stat. 135, 136), as amended by the Act of October 9, 1940 (Public, No. 812), $49,414.

As amended, this paragraph will provide for continuing the maintenance of the Arlington Experiment Farm, pending the establishment of necessary buildings and facilities at a new site (as provided by the Act of October 9, 1940) and the gradual transfer of the research work from the Arlington Experiment Farm to the new site.

WORK UNDER THIS APPROPRIATION

General. The Arlington Farm is a highly improved 400-acre tract maintained in Virginia, near Washington, D. C., provided with specially equipped laboratories, greenhouses, barns, shops, and other buildings to furnish facilities for conducting experiments and practical farm tests covering a wide range of research work, national in scope, principally for the Bureau of Plant Industry, but also available for the Bureau of Agricultural Chemistry and Engineering, Public Roads Administration, Bureau of Entomology and Plant Quarantine, Agricultural Marketing Service, Soil Conservation Service, and other branches. By furnishing similar facilities common to the many activities from a central station, duplication of effort and equipment is avoided and the cost of operation appreciably reduced. This item provides funds for the general maintenance of the plant and farm facilities. The work of other divisions in the Bureau of Plant Industry and of other Federal bureaus and departments is conducted at cost on a reimbursement basis.

Project 1. Arlington Farm maintenance of facilities for basic plant research:

Objective: To continue to maintain and operate a general experiment farm and agricultural station on the Arlington estate, in Virginia (in accordance with provision of the Act of Congress approved April 18, 1900), pending removal to and reestablishment at another site (as provided by the Act of October 9, 1940).

Significance: The Arlington Farm is in reality a large out-of-doors laboratory at which research in the following fields is in progress: Agronomic and pathological investigations of wheat, oats, barley, rice, rye, and sorghum; genetics and other studies of corn; selection, breeding, cultural, and pathological studies of lespedeza, alfalfa, sweet and red clover, zig zag clover, vetch, crotalaria, soybean and related legumes, turf grasses; growing Asiatic chestnuts and determining their susceptibility to diseases; investigations on mushroom diseases and culture; sugarcane and sugar beet investigations; tobacco and plant nutrition

studies, including diseases of tobacco and their control and the growing of tobacco of high nicotine content for use in insecticides; germination studies of seeds, field tests to determine identity, and investigations with legume and other soil organisms, including greenhouse control work on commercial legume bacteria and cultures; improvement of special harvesting and fertilizer placement equipment; cereal and forage insect investigations, and many others.

The research work done at Arlington aims chiefly at the solution of problems of national scope and significance. Technique and new materials developed here are sent to other field units of the Department and to cooperating State experiment stations in all parts of the country. It is intended to continue and further develop this work at the new site.

Plan and Progress of Work: Under this appropriation a central administrative and service unit is maintained that operates the Arlington Experiment Farm; furnishes cultural, mechanical, custodial, and watch services; assigns land areas for experimental purposes; provides agricultural implements, horses, and equipment; maintains a labor force for assignment to research projects, and in large part supervises this labor; operates a central heating plant, maintains power, water, drainage, gas, sewerage, telephone, and road systems, furnishes transportation facilities for supplies and materials, makes procurements, and issues supplies. Work done for other branches is conducted at cost on a reimbursement basis. These services will continue at Arlington until similar services can be provided at the new site.

With respect to the new site, for which land is being acquired, plans for necessary greenhouses and headhouses will be submitted for bids by April 1, 1941; and contracts for two laboratory buildings will be let within the fiscal year 1941. It is expected that contracts on the remaining buildings will be let during the fiscal year 1942. In the meantime, the use of farm land, greenhouses, laboratories, etc., will be advanced as rapidly as these facilities become available.

(c) REMOVAL AND REESTABLISHMENT OF ARLINGTON FARM, VIRGINIA

First Supplemental Civil Functions Appropriation Act, 1941, under head of "War Department, Military Activities, Quartermaster Corps", for transfer to the Department of Agriculture (to be available until expended)	$3,200,000
Budget Estimate, 1942	- -

This is a non-recurring item provided in the War Department appropriation in the First Supplemental Civil Functions Appropriation Act, 1941, as follows:

Removal and reestablishment of Arlington Farm, Virginia: For the removal and reestablishment of the functions and activities at Arlington Farm, including the acquisition of lands by purchase or by condemnation, the construction and installation of buildings, equipment, and utilities and appurtenances thereto, including the employment of persons and means in the city of Washington and elsewhere, $3,200,000 to remain available until expended: Provided, That this appropriation shall be transferred to the credit of the Secretary of Agriculture for expenditure by him: Provided further, That upon the transfer of the activities of the Department of Agriculture from Arlington Farm, so much of the land thereof as may be required by the War Department shall be transferred to the control and jurisdiction of the latter Department.

This appropriation was requested by the President (Senate Doc. 287, 76th Congress) as an urgent item in the National Defense Program in order that Arlington Farm might be released in its entirety for military purposes. The ready accessibility of land and research facilities at Arlington just across the Potomac River from Washington has made it possible for the research staff of the Bureau of Plant Industry to utilize the experimental plots, greenhouses and other technical facilities at Arlington and the laboratories available in Washington with equal facility and with no reduction in effectiveness. The availability of all of these facilities immediately at hand is, of course, necessary in such work. It was not possible to obtain a site for the experimental plots, greenhouses and other technical facilities sufficiently adjacent to the Washington laboratories of the Department to permit the continuation of their joint use as in the case of the Arlington-Washington facilities, and it therefore is necessary to provide all of these resources at the new location. In accordance with this program, suitable land is now being purchased immediately adjacent to the U. S. Horticultural Field Station on the Washington-Baltimore Boulevard near Beltsville, Maryland, upon which to continue the field experimental work with fertilizers, crops, soils, and soil-crop relationships; to permit the construction of greenhouses, farm buildings, offices, laboratories and other facilities required to permit the continuation of the research program of the Bureau of Plant Industry.

A similar arrangement was developed when the Horticultural Field Station was established, and it was found possible to transfer the entire staff of the Division of Fruit and Vegetable Crops and Diseases, and subsequently two other Divisions (Drug and Related Plants and Nematology), to the new location with a gratifying improvement in the effectiveness and efficiency of the entire operation.

The functions and activities of Arlington Farm are primarily to aid in carrying out the functions and activities of the Bureau of Plant Industry as a whole, in plant, soil and fertilizer research. Most of the Divisions of the Bureau have field plots, greenhouses, laboratories and other facilities at Arlington Farm and every Division has a direct and vital interest in the work done there. Hence, the relocation and transfer of the activities and functions of Arlington Farm entails the transfer from Washington to the new site of the major portion of the Bureau's personnel, including research workers, laboratory technicians, farm laborers, and the facilitating library and business activities. As the transfer of the bulk of the work of the Bureau to the new location will create difficult administrative and operating problems, it is eminently desirable progressively to move all, or virtually all of the local staff of the Bureau to the new location, if it is possible to accomplish this with the facilities that must necessarily be provided for the activities now conducted by the joint use of the Arlington-Washington facilities. It is also hoped that the facilities to be provided at the new site will be sufficiently adequate to permit the inclusion there of the fertilizer work now at the Beltsville Research Center, which was transferred to the Bureau of Plant Industry on July 1, 1940, thus bringing about the closest possible integration of the soils, fertilizer, and plant research. This would locate all of the work at one site instead of four as at present.

With combined headquarters, personnel and facilities, together with joint land, greenhouses, laboratories, and offices located at one site, the effectiveness and economy of operation of the Bureau of Plant Industry in carrying forward the soils, fertilizer, and plant research will be increased. This will also make it possible to release for occupancy, by Department units now housed in rented quarters, valuable office and laboratory space in the Washington buildings of the Department of Agriculture with rental savings ranging up to $200,000 per year.

Small units of the Bureau of Chemistry and Engineering (work with farm implements) and of the Bureau of Entomology and Plant Quarantine (cereal and forage insects) now located at Arlington Farm are being relocated at the Beltsville Research Center through provision of facilities to be constructed on land already owned by the Government.

(d) BOTANY

The work under this appropriation, for which $76,635 was provided in the 1941 Act, is consolidated in the estimates for 1942 under the following items:

"Cereal Crops and Diseases" (weed control investigations).....	$40,000
"Fruit and Vegetable Crops and Diseases" (wild plant improvement--blueberries, gooseberries, etc.)...............	5,000
"Plant Exploration, Introduction, and Surveys" (economic herbarium maintenance and systematic botany studies).......	31,635
Total..	76,635

(e) CEREAL CROPS AND DISEASES

Appropriation Act, 1941	$500,000
Transferred in 1942 Estimates from:	
"Botany" (weed control investigations)	40,000
"Genetics and biophysics" (all)	25,000
Total available, 1941	565,000
Budget Estimate, 1942	565,000

PROJECT STATEMENT

Projects	1940	1941 (Estimated)	1942 (Estimated)
1. Barley investigations.........	$64,290	$60,109	$60,109
2. Corn investigations...........	159,935	144,561	144,561
3. Seed flax investigations......	24,665	21,513	21,513
4. Sorghum investigations........	25,890	24,534	24,534
5. Oat investigations............	43,535	39,559	39,559
6. Rice investigations	43,700	43,098	43,098
7. Wheat investigations..........	215,566	191,626	191,626
8. Weed control investigations...	39,850	40,000	40,000
Unobligated balance..............	5,365	- -	- -
Total appropriation.....	622,796*	565,000*	565,000

* Includes $71,675 in 1940 and $65,000 in 1941 for work proposed for transfer in the 1942 estimates.

CHANGE IN LANGUAGE

The estimates include proposed changes in the language of this item as follows:

> For the investigation and improvement of cereals, including corn, and methods of cereal production and for the study and control of cereal diseases, [and] for the investigation of the cultivation and breeding of flax for seed purposes, including a study of flax diseases, [and] for the investigation and improvement of broomcorn and methods of broomcorn production, [$500,000] <u>and for determining the distribution of weeds and means for their control, $565,000, of which $40,000 shall be available for investigations concerning the control and eradication of white-top, bindweed, and other noxious weeds.</u>

The first and second changes eliminate the words "and", which are superfluous in the language.

The third change merely transfers the authority to conduct weed control investigations formerly granted under the subappropriation "Botany", involving an item of $40,000. The subappropriation "Botany" is discontinued and botanical investigations transferred to "Fruit and Vegetable Crops and Diseases" and "Plant Exploration, Introduction, and Surveys". Weed-control investigations are logically a function of a crop-production unit and can be most effectively carried on in connection with cereal-production work.

WORK UNDER THIS APPROPRIATION

<u>General</u>. Work under this appropriation is concerned with improving the quality and insuring economy and stability in growing the Nation's bread and feed crops; also with the control of weed pests of grain fields. The cereal crops occupy a total of 225,000,000 acres each year and are the most important single element of American agriculture. The program is concerned with eight important items, as follows: (1) barley, (2) corn, (3) seed flax, (4) sorghum, (5) oats, (6) rice, (7) wheat, and (8) weed control.

Project 1. <u>Barley Investigations</u>:

<u>Objective</u>: (1) To develop the most efficient methods for growing barley; (2) to develop breeding methods and breed improved varieties of barley satisfactory in yield, quality, and other characters and resistant to diseases, insects, drought, cold, heat, and other hazards; (3) to determine the malting and other values of standard and new varieties of barley and the effect of soil, weather, etc., upon the growth and value of barley; and (4) to study the diseases of barley - among others, rusts, smuts, scab, stripe, scald, and blights - and to develop means for their control, including the breeding of resistant sorts.

The Problem and its Significance: Barley is grown in this country on approximately 12,000,000 acres each year. The crop is produced principally from spring sowing in the upper Mississippi Valley and adjacent Lake States, with some in the Intermountain and Pacific Coast States and some from fall sowing in the Southern States. During the 12 years 1928-1939 the average annual production was 238,290,000 bushels. About 65,000,000 bushels are required each year for the malt-using industries. During the middle and late years of the 1920-1930 decade an average of about 30,000,000 bushels was exported each year, but in recent years exports have fallen to only 5,000,000 to 8,000,000 bushels. Most of the crop is used as feed.

The value of barley as a feed crop is widely recognized, particularly for areas where corn cannot be grown successfully and to fill in between successive corn crops. The irritation and inconvenience of handling the most widely grown and most productive varieties, characterized by long and very rough awns, has tended to reduce the use of the crop in spite of its true values. Certain hooded varieties, more pleasant to handle, are grown to a limited extent to get away from the inconvenience of awns. The awned varieties are more productive, however, than the hooded sorts. There are also smooth-awned types less disagreeable to handle, and through breeding a number of productive sorts have been developed which are well adapted to certain areas. It remains to produce such smooth-awned combinations for the entire country.

Diseases of Barley

Diseases take a heavy toll from the barley crop each year. In 1937 the estimated loss totaled 22,000,000 bushels or approximately 10 percent of an average crop. This loss is important, not only because of a direct effect in crop production, but even more so because of its effect on the quality and use of the crop. Scab, helminthosporium blight, stripe, and stem rust seriously reduce malting values. In years of heavy disease infection adequate supplies of satisfactory malting quality are hard to find. Scab, causing a severe emetic effect, makes the grain unfit for feeding to hogs and horses. The disease problem is particularly acute in the North Central area where most of the crop and the most important part of the malting supplies are grown. Some progress has been made in breeding disease-resistant varieties, but the most of the job remains to be done.

Barley for Malt

Malt can be made from any barley, but there are large differences in the malting values of different varieties. Some varieties, now widely grown and acceptable to farmers because of good yields and smooth awns, are not equally acceptable to the maltster. There is urgent need for new varieties resistant to diseases, satisfactory in yield and handling characteristics, and equal to the best malting varieties now available.

Winter Barley for South

The Southeastern States, due to the failure of the foreign market for cotton, the necessity for controlling soil erosion, and the need for providing locally grown subsistence for a large unemployed group, are facing an adjustment of crop acreage away from the inter-tilled cotton. A more cold-resistant winter barley, to provide a winter soil cover to check erosion, to supply fall, winter, and early spring pasture, and later to furnish a concentrated feed for producing home-grown meats, is needed to help meet this situation.

Plan and Progress of Work: The work is conducted principally in the field cooperative with the State Agricultural Experiment Stations of Wisconsin, Minnesota, Iowa, North Dakota, Montana, Nebraska, Kansas, Texas, Arizona, California, Oregon, Utah, Idaho, and Colorado. New strains from the breeding program are distributed to any State desiring to work with the crop. In cooperation with the Wisconsin Station, the malting values of standard varieties and of new strains are determined in order to choose those which should be distributed for growing. The Trebi variety, produced in this program, is the most widely adapted high-yielding variety now grown in the United States. Smooth-awned varieties such as Vaughn and Flynn have been produced and distributed. Measures have been developed to control scab in barley and to utilize scab-infected barley for feeding cattle and other ruminants. New varieties better in disease resistance and of better malting value are under test.

Project 2. Corn Investigations:

Objective: (1) To develop the most efficient methods for growing corn; (2) to develop breeding methods and breed improved corn hybrids (including sweet corn and pop corn) satisfactory in yield, quality, stalk stiffness, and other characters and resistant to diseases, insects, drought, wind, and other hazards, in order to reduce the risks of growing corn; (3) to determine the composition, values, and quality of new corn hybrids and the effects of soil, weather, and other factors on the growth and value of corn; and (4) to study the diseases of corn, including wilt, ear-, stalk-, and root-rots, smuts, rusts, and mosaics, and to develop means for their control, including the breeding of resistant hybrids.

The Problem and its Significance: The corn crop is the backbone of American agriculture. It supplies the principal source of feed for the livestock and dairy industries. In the South, in particular, it forms an important part of the diet for much of the population. The crop is grown in all States of the Union, the annual acreage ranging from 88,000,000 acres to over 100,000,000 acres in recent years. Production for the 12 years ending with 1939 averaged 2,356,000,000 bushels. Over 85 percent of this total is fed to livestock on the farms where grown. The remainder enters commerce, some 250,000,000 bushels being used in the manufacture of starch, corn sugar, alcohol, cereal foods, etc., and by the brewing and distilling industries. Corn

fodder and stover are important rough feeds, and the stalks, used now in limited amounts for the manufacture of wall-board, cellulose, and similar products, are an immense potential source of industrial raw material for the production of cellulose, plastics, solvents, motor fuels, and an almost infinite variety of industrially useful organic derivatives.

Hazards of Corn Production

Annual fluctuation in yield of corn, as with other crops, is a disturbing element in stabilizing American agriculture. These fluctuations are due principally to losses from diseases and insect pests and to the effects of unseasonable low temperatures at planting time, heat and drought during the growing season, and fall frosts which occur before the crop is mature. Losses from root-, stalk-, and ear-rots, for example, are estimated to total 9 to 20 percent of the average crop each year, at the same time lowering values for feed or industrial uses. Insects seriously reduce stands in some one or more areas of the country each year and, particularly in the South, often heavily damage the matured grain, both in the field and in storage.

Research has amply demonstrated that, through breeding, strains for each area can be developed which possess greater early and late resistance to the effects of cold, greater resistance to drought and heat, and resistance to diseases and insects. Differences in food and feed values and in properties most important for industrial uses have been shown, opening up the potentialities of breeding special strains for new industrial or other outlets as they are shown to be needed.

The corn crop, grown in rows and clean cultivated, is an accelerator of soil depletion and erosion when grown too continuously, or on land too rolling in contour, or under a system of management which does not otherwise provide for soil building and maintenance. The proper use and conservation of national soil resources requires, therefore, that our supplies of this immensely valuable basic crop be produced on the smallest possible acreage in order to permit the land to be in grass, legumes, and other soil-building crops for as much of the time as possible and to avoid using lands where maintenance problems are most serious. High-yielding varieties and the elimination of wastes and losses from diseases and rots in the field and in storage are essential to this end.

Hybrid Corn Boosts Yields

In cooperation with the State agricultural experiment stations, great progress has been made in developing methods for breeding and producing strains of hybrid corn for the different Corn Belt States, which have contributed materially toward the solution of the various problems noted above. The average acre yield of the four Corn Belt States of Ohio, Indiana, Illinois, and Iowa for the 10-year period

1928-1937 was 34.8 bushels. In 1939, following a large buildup in the acreage of hybrid corn to 27 percent of the total, the average acre yield was 51.6 bushels. A comparison of yields in these States with those in other States with little or no hybrid corn acreage indicates that this increased yield was due principally to hybrid corn. The average market quality of the crop and freedom from damage by ear-rots also have been improved materially as shown by the inspection data at terminal markets.

In spite of this great accomplishment for the Corn Belt, much remains to be done for other parts of the country and even in the Corn Belt itself. Certain of the otherwise good hybrids have proven susceptible to Stewart's wilt, which has not ordinarily attacked field corn, and as a result yields and quality have been impaired. During 1940 there were apparent large differences in the ability of the different hybrids to withstand the unfavorable cold, wet conditions of the planting season, average replanting being high. In addition, most of the hybrids, in spite of high average production, have some one or more weaknesses which need to be corrected by the methods already proven effective.

Hybrids Needed in South

In the Southern United States, where corn is the most important crop on an acreage basis (12,546,000 acres of cotton and 23,298,000 acres of corn in 1939), average acre yields for the 10 years 1928-1937 were 14.8 bushels compared to the 34.8 bushels for the four Corn Belt States previously noted. Because of the greater emphasis on cotton, corn has always been relatively neglected. The necessity for adjusting cotton acreages, the pressure of erosion in these States, and the need for food and feed crops for supporting a large part of the population on a subsistence rather than a cash income basis, means that corn must receive more attention in this section. Because of climatic conditions, diseases and insects are even more serious here than in the Corn Belt. The same methods which have given results in the Corn Belt area can be equally effective in the South. A start has been made, but the real job remains to be done.

Plan and Progress of Work: The corn research program is conducted in cooperation with the State Agricultural Experiment Stations of Ohio, Indiana, Illinois, Wisconsin, Iowa, Missouri, Kansas, Louisiana, Tennessee, and Georgia. Hybrids are developed at the several stations, and through interchange of breeding material their adaption is determined. The inbreds and hybrids are tested for yield, grain quality, time of maturity, cold, heat, and drought resistance, strength of stalk, and for resistance to the various diseases and insect pests. Stocks for producing hybrids are released to growers through the cooperating State stations. Breeding material is also supplied to other experiment stations as desired. Ninety percent of the inbred lines which are the basis for the Nation's 25,000,000 acres of hybrid corn come from this cooperative program. New and even better inbreds are in process of development, and a number of these will shortly be ready to replace older lines which, while valuable, have proven deficient in one or more important features. Progress is being made in developing resistance to ear- and stalk-rots and to insects such as the corn earworm, chinch bugs, and aphids.

Project 3. Seed Flax Investigations:

Objective: (1) To develop the most efficient methods for growing seed flax in different areas; (2) to develop breeding methods and breed improved varieties satisfactory in yield, quality, and other characters and resistant to diseases, insects, cold, heat, drought, and other hazards, in order to reduce the risks of growing flax (and buckwheat); (3) to determine the oil content, oil quality, and other values of new flax varieties and the effects of soil, weather, and other factors on the growth and value of flax; and (4) to study the diseases of flax and to develop means for their control, including the breeding of resistant sorts.

The Problem and its Significance: Seed flax is grown on an average of approximately two million acres, producing only 7 to 20 million bushels of the some 30 million bushels of flaxseed required annually for the linseed oil needed for domestic use. Most of this production is in Minnesota, the Dakotas, California, and Kansas.

New Varieties

The development of wilt-resistant varieties and of weed control methods has permitted the revival of flax growing on old lands. Experiments with new varieties and with improved cultural practices resulted in the establishment of the flaxseed industry in California and, more recently, in Texas. Experiments are being conducted to determine the adaptation of seed flax to the Pacific Northwest. Bison, the leading variety of flax in the United States, is productive, wilt-resistant, and high in oil content but is deficient in respect to the quality of oil produced and in its susceptibility to the rust and pasmo diseases. These deficiencies are amenable to improvement by breeding. Resistance to cold is essential to the production of fall-sown flax in Texas and to a certain extent in California. Flax production has been greatly curtailed by drought during recent years in Montana and the Dakotas.

The development of productive, disease-resistant, cold-resistant, and high-quality varieties of flax would stabilize production, provide a large protion of our domestic requirements, and permit the more extensive growing of flax on land now devoted to wheat, cotton, and other surplus crops. The breeding of suitable flaxes having a higher quality of oil than Bison would eliminate the necessity of blending with oil from imported flax in order to bring the product up to standard specifications.

Plan and Progress of Work: The work is conducted in cooperation with State agricultural experiment stations, chiefly in Minnesota, North Dakota, Montana, Kansas, Texas, and California, and to a limited extent in Oregon, Washington, Idaho, Iowa, and other States. Breeding and testing are done in the field and in greenhouses. Tests of oil yield and of several measures of oil quality to be used as a measure of the value of strains and methods and to determine the effect of locality on the value of flax are conducted in chemical

laboratories on new flaxseed strains grown throughout the country. As a result of this program seed-flax growing has been established in recent years in California and Texas, based on varieties produced as a part of this work. Improved varieties better in oil content and quality and resistant to wilt and rust are being increased.

Project 4. Sorghum Investigations:

Objective: (1) To develop the most efficient methods for growing sorghums (including broomcorn) in different areas; (2) to develop breeding methods and breed improved varieties satisfactory in yield, quality, and other characters and resistant to diseases, insects, drought, cold, wind, and other hazards, in order to reduce the risks of growing sorghum; (3) to determine the palatability, feeding, and market values of new grain and forage sorghums and the effects of soil, weather, and other factors on the growth and values of sorghum; and (4) to develop control measures for diseases of sorghums, including the breeding of resistant sorts.

The Problem and its Significance: About 12,000,000 acres of land mostly in the southern Great Plains States are planted to sorghums annually, and about 300,000 acres are devoted to broomcorn. The sorghums provide essential grain and forage in sections too hot or dry for successful corn production and, in addition, are planted extensively to help check soil blowing. The sorghum acreage has increased about a third since the beginning of the present drought cycle. Sorghum is subject to injury from extreme drought and cool weather. Most varieties are too late to mature in the northern States. Additional varieties are needed that have short strong stalks which permit economical harvesting with a combine.

All but three of the strictly forage sorghums have brown, unpalatable, chaffy seed of little value as feed. Diseases such as smuts and leaf spots reduce the quality and yield of sorghum. The occurrence of Pythium root rot has spread rapidly but promises to be brought under control by the breeding of resistant varieties. A new and destructive disease called "charcoal rot" has recently appeared in Oklahoma and Texas which it is hoped may likewise be controlled by breeding. Sorghum seeds and young seedlings are extremely subject to injury from blight organisms, and this necessitates much replanting. Sorghums also are attacked heavily by insects such as chinch bugs, corn earworm, and aphids.

Sorghum production has been extended into northern and high altitude sections in South Dakota, Nebraska, and Colorado, where early maturity and adaptation to cool conditions are essential. This extension has been possible only as a result of the breeding of short-season varieties but further improvement is needed badly. Much of the broomcorn now produced is of inferior market quality due to poor panicle exertion, discoloration from insect and other injury, and other unsatisfactory characteristics which might be eliminated by breeding.

The development of improved quick-maturing varieties well adapted to short-season conditions would make feed supplies more certain, help to stabilize livestock production and diversified agriculture, and aid in soil-conservation practices throughout the Great Plains region. A reduction of losses from diseases, insects, and drought as a result of breeding resistant varieties would go far to stabilize the production of feed supplies over much of the central and south-central areas of this country.

Plan and Progress of Work: The work is conducted at field stations in cooperation with the State agricultural experiment stations, chiefly in Texas, Oklahoma, and Kansas, the leading States in sorghum production. Limited experiments are conducted in Colorado, Nebraska, Wyoming, South Dakota, New Mexico, Arizona, California, Oregon, and elsewhere. Crosses are made for certain of the previously stated definite objectives, and the selected progenies are tested where they are likely to be adapted. The cultural requirements of new varieties also are determined. All promising new breeding material is tested for resistance to diseases and insects. New varieties are distributed to farmers through cooperating State stations. The combine varieties, Beaver, Sooner, Kalo, Early Kalo, Colby, etc., have been widely distributed and utilized. Sorghum production has been pushed northward in the dryer Great Plains area by the introduction of these earlier dwarf varieties. The "milo" disease has been solved and a complete control developed through selecting resistant strains of all the important commercial sorts.

Project 5. Oat Investigations:

Objective: (1) To develop the most efficient methods for growing oats in different areas; (2) to develop breeding methods and breed improved varieties satisfactory in yield, quality, and other characters and resistant to diseases, insects, heat, cold, drought, wind, and other hazards, in order to reduce the risks of growing oats; (3) to determine the effects of soil, weather, and other factors on the growth and quality of oats; and (4) to study the diseases of oats, and develop means for their control, including the breeding of resistant sorts.

The Problem and its Significance: Oats are grown on approximately 35,000,000 acres annually. About one billion bushels are produced. Of this, about 5 percent is used in the manufacture or rolled oats, oat flour, and other products and the balance for feed. In addition to their value for feeding livestock, oats are grown largely in rotations with corn and as a companion crop for the sowing of clover and other legumes. Oats thus provide a supply of feed grain from fields in which legume seedings are becoming established. Despite the fact that oats usually are not grown at a profit, their production involves little additional expense of labor, and no other crop is so well suited to the rotation systems of the Corn Belt. The growing of legumes in rotation is an essential step in soil conservation.

In the South winter oats furnish needed feed for livestock and in addition provide an excellent winter cover to check soil erosion. Winter oats often suffer from cold injury. Both winter and spring oats are subject to heavy losses from diseases, particularly crown rust, stem rust, and kernel smuts. The yields often are reduced by heat, drought, and lodging.

The acre returns from growing oats could be increased greatly by breeding improved varieties that are resistant to the above-mentioned diseases, as well as to cold, heat, and drought. Increased yields of oats would reduce the cost per bushel and thus encourage additional use in soil-conserving rotations.

Plan and Progress of Work: The work is conducted in cooperation with State agricultural experiment stations at about 80 points in the United States. The primary breeding stations are in Iowa, Idaho, and Virginia, with additional experiments in New York, North Dakota, Montana, Washington, Oregon, California, Arizona, Texas, Oklahoma, Kansas, Nebraska, Arkansas, and Georgia, and informal cooperation is maintained with the experiment stations of nearly all the remaining oat-growing States. Hybrid selections of oats developed in the experiments are tested wherever they seem likely to be adapted. They are being tested for resistance to diseases, heat, cold, and drought, as well as for yield and adaptation. New and improved disease-resistant varieties originating in this program have been distributed in Virginia, Florida, Louisiana, New York, Michigan, Wisconsin, Iowa, Kansas, Colorado, Texas, Oregon, and Idaho and from these centers have spread over the entire oat-growing territory. Even better varieties are being increased for distribution.

Project 6. Rice Investigations:

Objective: (1) To develop the most efficient methods for growing rice in different areas; (2) to develop breeding methods and breed improved varieties satisfactory in yield, quality, and other characteristics and resistant to diseases, insects, cold, heat, and adverse soil and water conditions; (3) to determine the milling and cooking quality of new rices and the effects of soil fertilizers, weather, and other factors on the growth and value of rice; and (4) to study the diseases of rice and to develop means for their control, including the breeding of resistant sorts.

The Problem and its Significance: Rice is grown on about one million acres annually. The production is approximately 50 million bushels. The crop is produced most successfully where there is a hot climate, a long growing season, ample irrigation water, topography favorable for check irrigation, adequate drainage, and a fertile soil which retains water readily. Consequently, the area adapted to rice in the United States is definitely limited, being restricted in large part to sections not equally well adapted to other agricultural use. Because of the high acre-costs of growing rice, large yields are essential to success. The maintenance of good yields on the present

rice lands will require improvement in varieties, fertilizer practices, and cultural methods. Diseases and insects damage both the yield and quality of rice. All the present domestic varieties of rice are deficient in either mill yields or cooking quality or both. Improvement in cooking quality should result in a greater consumption of the domestic crop.

The development of satisfactory soil-building practices and of varieties resistant to diseases and insects, as well as of good yield, milling quality, and cooking quality, would aid greatly in assuring an adequate supply of good rice for the continental United States and its island possessions. It also would insure the continued productive use of the heavy lands now cultivated to rice which are not well suited to other crops.

Plan and Progress of Work: The work is conducted principally at five field stations located in rice-growing sections of Louisiana, Texas, Arkansas, California, and Missouri. Tests of rice quality are conducted in the laboratory and studies of rice diseases are made in the field, greenhouse, and laboratory. Thousands of selections from crosses between rice varieties are being tested for various desired characteristics. New kinds of fertilizers and various cultural and irrigation methods are under trial. In California 95 percent of the rice acreage is in varieties produced in this program. In the Southern States a steadily increasing percentage of the acreage is cultivated to the improved high-quality varieties Fortuna, Pecoro, and Nira. These varieties are superior in culinary quality to other varieties now grown and command a premium of 75 cents to $1 or more per barrel. New varieties equally good in culinary value and better in disease resistance are under test. The value of fertilizers in growing rice has been demonstrated, methods of weed control worked out, and proper dates and rates of sowing determined.

Project 7. Wheat Investigations:

Objective: (1) To develop the most efficient methods for growing wheat in different areas; (2) to develop breeding methods and breed improved varieties of wheat and rye satisfactory in yield, quality, and other characters, and resistant to diseases, insects, drought, cold, wind, and other hazards, in order to reduce the risks of growing wheat; (3) to determine the breadmaking and other values of new wheats and the effects of soil, weather, and other factors on the growth and values of wheat; and (4) to study the diseases of wheat and develop means for their control, including the breeding of resistant sorts.

The Problem and its Significance: About 55,000,000 acres of wheat are grown each year in the United States. Even in recent years production has been variable, ranging from a low of 525,000,000 bushels in 1934 to over 930,000,000 bushels in 1938, with an average since 1928 of 768,000,000 bushels. Normal domestic requirements for food, feed, and seed approximate 660,000,000 bushels, leaving some 100,000,000 or more bushels for export or other use.

Hazards of Wheat Production

Fluctuations in the annual crop are due principally to the hazards of winterkilling, drought, high temperatures, lodging, and disease and insect pests, such as stem and leaf rust, bunt, loose smut, Hessian fly, etc. Plant diseases cause a loss each year ranging from 4 to 32 percent of the potential crop. Losses from stem rust, leaf rust, and bunt in particular run into the millions of dollars each year. Winterkilling likewise causes heavy losses in acreage, and is particularly objectionable because the crop may be almost entirely destroyed in certain areas, as in the Ohio River Valley in 1928. Of the 45,000,000 acres of winter wheat sown the fall of 1939, 24.3 percent was abandoned by May 1, 1940.

Hard red winter wheat is grown mostly in the States of the central and southern Great Plains and is used for bread flour with some surplus for export. Hard red spring wheat is grown mostly in the northern Plains and prairie States and is used for high-quality bread flour largely for domestic consumption. The principal hazards in growing these classes of wheat are heat, drought, and often severe epidemics of stem and leaf rusts. Winter cold also causes severe losses in hard red winter sowings.

Annual losses from stem rust in hard red spring wheat alone in excess of 150,000,000 bushels have occurred as recently as 1935, 1937, and 1938. Epidemics of stem rust, starting in Texas, have under favorable conditions swept across the country, leaving disaster and ruin behind. The introduction of the stem-rust resistant Thatcher, now grown on more than 6,000,000 acres in the hard red spring area, has been a great contribution toward eliminating such losses. Thatcher is not resistant to leaf rust, however, and in 1938 was seriously injured by that disease. The problem in the central United States, therefore, is to breed hard red winter and hard red spring wheats resistant to cold, drought, heat, and stem and leaf rusts and equal in yield and bread-making quality in ordinary years to the varieties now available.

In the area from the Rocky Mountains to the Pacific Coast soft wheats are principally grown. Part of this crop is available for export. The climatic and cultural conditions of this region favor the bunt disease, which has caused heavy losses. In 1934 as much as 34 percent of the crop graded smutty at the Pacific Northwest terminals. Rapid progress has been made in breeding bunt-resistant varieties and the growing of these varieties has reduced smutty receipts and has done much to correct previous damage. Unfortunately, however, the existence of different races of the disease organism, differing in ability to attack various wheat varieties, complicates the breeding program and has made it necessary to combine as many different kinds of resistance in single varieties as possible. The difficulty of getting desired grain quality combined with desired disease resistance must also be recognized. One of the new, highly

bunt-resistant, good yielding varieties, Rex, recently introduced and found to be very satisfactory to the farmer from the production standpoint, does not give satisfactory flour yields in the mill. Cold, heat, and drought damage likewise are important here, as elsewhere, and the problem is to breed varieties meeting these requirements, as well as disease and quality standards.

Soft red winter wheat is grown principally in the northern half of the United States east of the Mississippi River. The flour is used principally for home baking and pastry and is consumed almost entirely in the United States. The problem is to breed soft red winter wheats equal in yield and quality to present standard varieties and resistant to Hessian fly, stem and leaf rusts, smut, and cold. The most serious of these problems are the losses from winterkilling and from the rusts. Winterkilling in 1928 almost wiped out this wheat in the Ohio Valley. Delayed seeding to escape damage from Hessian fly is probably responsible for a substantial part of winterkilling loss. Fortunately resistance to Hessian fly has been found in certain strains, and it seems probable that desirable strains resistant to the fly can be developed by breeding.

In the southeastern United States winter wheat is a very satisfactory protection against soil erosion and in normal years will furnish much winter pasture. Lack of rust-resistant varieties prevents the full use of wheat for this purpose. The problem is to breed rust-resistant varieties adapted to the area.

The development of productive, high-quality wheat varieties adapted to the different regions of the United States and resistant to diseases, insects, cold, heat, and drought, would remove the most serious hazards now facing the wheat farmer in the United States, make possible a better planned and more stabilized agriculture, and, through stabilization, make possible the better use of soil resources and their conservation.

Plan and Progress of Work: The work is conducted in cooperation with the State agricultural experiment stations in most of the important wheat growing States. Four regional wheat improvement programs are organized as follows: (1) Hard red winter wheat region, (2) Hard red spring wheat region; (3) Soft red winter wheat region; and (4) Western intermountain and Pacific Coast wheat region. In each region a coordinated program with uniform plans for the entire area and a free interchange of materials between States and stations have been developed. The wheat collections of the Division of Cereal Crops and Diseases are made available to all cooperators, and the Division undertakes to develop crosses and to make tests for the State stations which the stations themselves cannot do. All new varieties and strains developed in the several regions are tested by the Division in the cooperative regional quality laboratories for milling values and for their usefulness in making of bread, pastry, macaroni, or other products. This latter is done to insure that new strains, otherwise desirable, meet required commercial standards. The smut-resistant varieties Ridit,

Albit, Oro, Rex, Hymar, and Regal have been distributed in the Pacific Northwest, resulting in a marked reduction in receipts of smutty wheat at terminal markets. The stem-rust-resistant varieties Thatcher, Pilot, and Rival have been distributed in the hard red spring wheat region, where their disease resistance and satisfactory milling and baking value have led to their largely supplanting Marquis and Ceres in the better producing areas. Tenmarq in the hard red winter area, and Wabash in the soft red winter area have been similarly important disease-resistant, high-quality contributions. Newer strains combining resistance to more strains of the smuts or to combinations of diseases and to insect pests are in process of development.

Project 8. Weed Control Investigations:

Objective: (1) To determine the noxious character of the some 1,500 species of troublesome weeds; (2) to study the life-histories of these weeds and the effects of different methods and treatments on them; and (3) from such data to develop effective methods of controlling the more noxious species.

The Problem and its Significance: Certain very aggressive weeds, numbering about 30 species and chiefly perennials with strongly creeping roots, have recently gotten out of control over wide areas. While known for many years, their destructiveness has increased enormously since about 1920. The chief reasons for this phenomenon are probably the depression, with attendant neglect of weed control, and long-continued dry weather, which always increases the production of weed seed and which lately caused the shipment into clean areas of much contaminated emergency stock feed. In 1920 the area occupied by crop-destroying weeds of this type was less than 1,000,000 acres. Today more than 6,000,000 acres are involved, and by 1946 it is estimated that more than 12,000,000 acres will be infested unless weeds are checked. These "noxious" weeds reduce crop yields by from 15 to more than 90 percent, and at an increased cost of production. No adequate or feasible means for controlling many of these pests are known. First-class good farming does not control them when they have once gotten out of hand. The situation requires research to develop more effective methods that can be used on farms at a reasonable cost. The Bureau, working with the State agricultural experiment stations, in five years of intensive research on bindweed control has found new methods which reduce the cost of control 30 to 50 percent. Similar studies are needed on other weeds.

Plan and Progress of Work: All this work is conducted in cooperation with the State agricultural experiment stations. Field experiments have been established on bindweed-infested areas in Minnesota, Iowa, Nebraska, Kansas, and Idaho. Hundreds of test plots at each station are subjected to various methods of tillage, cropping, and treatment with weed-killing chemicals. From these and other plots thousands of root samples are dug and chemically analyzed for their content of plant food reserves. The growth and recovery of the treated plants are thus observed and systematically measured. The response of the

weed to every possible circumstance is recorded and from these data the most effective and economical methods are determined.

In 1935, when this project began, the area infested with bindweed was doubling in size every six to seven years. Because of lack of an effective control method, virtually no bindweed was being destroyed. The situation was causing grave alarm. In 1939, operating with new control methods, 80,000 acres of bindweed were being destroyed in Kansas. In 1940 operations were begun on about 175,000 acres in that State, or approximately 50 percent more than the area of annual increase. The situation is no longer hopeless. In Washington, where infested land sold in 1936 for $32.50 an acre and non-infested land for $75, clean land still sells for $75 while infested land brings $60 to $65 due to a saving of 60 percent in the cost of eradication by the new methods. The solution of similar problems with other weeds will restore extensive areas to profitable production and bring back tax and loan values. It is of distinct advantage to the Government since much infested acreage is on Government-financed reclamation projects.

(f) COTTON AND OTHER FIBER CROPS AND DISEASES

Appropriation Act, 1941	$408,345
Transferred in 1942 Estimates from "Soil-fertility investigations" (cotton soil-fertility investigations, and cotton root-rot soil and fertilizer investigations)	35,190
Total available, 1941	443,535
Budget Estimate, 1942	443,535

PROJECT STATEMENT

Projects	1940	1941 (Estimated)	1942 (Estimated)
1. Cotton investigations (production, improvement, and diseases):			
(a) General cotton breeding and improvement investigations	$100,150	$99,020	$99,020
(b) Egyptian cotton breeding and improvement investigations	22,035	22,178	22,178
(c) Sea Island cotton breeding and improvement investigations	14,700	14,700	14,700
(d) Cotton genetic investigations	53,500	51,160	51,160
(e) Studies of the structure and growth of the cotton plant and of cotton fibers	9,300	7,100	7,100
(f) Cotton plant nutrition and other physiological investigations	64,240	64,500	64,500
(g) Cotton disease investigations	28,000	28,000	28,000
(h) Cotton quality research from the standpoint of production	38,400	31,200	31,200
(i) Cotton culture investigations	44,281	44,390	44,390
(j) Investigations on establishing improved cotton seed stocks, including one-variety community methods	65,000	63,000	63,000
Total, Cotton investigations	439,606	425,248	425,248

Projects	1940	1941 (Estimated)	1942 (Estimated)
2. Fiber plants other than cotton:			
(a) Hard fiber studies	$7,945	$8,050	$8,050
(b) Fiber flax agronomic and breeding investigations	4,650	4,650	4,650
(c) Hemp investigations ...	5,568	5,587	5,587
Total, Fiber plants other than cotton	18,163	18,287	18,287
Unobligated balance	1,806	- -	- -
Total appropriation ...	459,575**	443,535*	443,535

* Includes $35,190 for work proposed for transfer in the 1942 estimates.

CHANGE IN LANGUAGE

The estimates include a proposed change in the language of this item as follows:

> For investigation of the production of cotton and other fiber crops, including the improvement by cultural methods, breeding, and selection, fiber yield and quality, <u>cotton soil-fertility,</u> and the control of diseases, [$408,345] <u>$443,535,</u> of which sum not less than $14,700 shall be used for experimenting in Sea Island cotton, including its hybridization with other varieties.

The change provides for the insertion of the words "cotton soil-fertility" which is coincident with the transfer to this appropriation of the cotton soil-fertility investigations hitherto conducted under the paragraph "Soil-fertility investigations", which is proposed to be discontinued as a separate item in the 1942 estimates.

WORK UNDER THIS APPROPRIATION

<u>General</u>. Under this appropriation work on the production and improvement of cotton and other fiber crops is conducted for the purpose of improving the quality and reducing the costs of growing cotton and other fiber crops. The work is divided into two general fields: (1) Cotton; and (2) other fiber crops.

Project 1. Cotton Investigations (production, improvement, and diseases):

Objective: To improve the quality of cotton for manufacture, to promote the more economic production of cotton, and to strengthen the position of American cotton in domestic and foreign markets, in order to increase the income of growers.

The Problem and its Significance: Such properties of cotton as staple length, strength, and fineness and other properties which go to make up the character and determine the use and value of cotton vary greatly. Staple length of different varieties and species varies from 1/2 inch to more than 2 inches. The strength of fiber, as determined by the bundle method, varies from 60,000 pounds to 120,000 pounds per square inch. The diameter and fineness and structure of the fibers vary to an even greater extent. These properties and certain combinations of them determine the value of cotton for different uses.

Variability in Fibers

The length of individual fibers in any given sample of cotton also varies; the sample that the classer designates as 1 inch is composed of individual fibers varying in length from 1/2 inch to 1-1/4 inches. Fineness of individual fibers also varies to a very large extent. The uniformity of these characters in a given lot is extremely important in manufacturing. Where strength is a prime consideration, as in making thread, spinners prefer a long, strong, fine cotton, with all of the fibers approximately of the same length and of the same degree of fineness. In making blankets, on the other hand, a short, coarse fiber with a relatively low degree of uniformity is satisfactory. The value of any cotton for a particular purpose, therefore, is determined by these important properties of the fibers and by the uniformity of properties throughout the bale.

Quality Factors are Inherited

These properties are known to be inherited to a very large extent and to be influenced to a lesser extent by soil moisture, fertility conditions, climate, and season and by organisms which attack the cotton fibers. The problem, therefore, as to quality is to develop varieties and strains of cotton that will produce uniformly high-quality cotton suitable for the various uses and types of manufacture.

Many of the longest and finest cottons (valued for their excellent spinning quality) produce relatively low yields, while short, coarse cottons of poor spinning quality in many cases produce high yields per acre. During the past 25 years breeders have developed high-yielding and early-maturing varieties to get ahead of the boll weevil and have paid little attention to quality and spinning value. Even the breeders who have been quality-conscious have been handicapped by a lack of reliable information as to the relative importance of those factors which contribute to quality and have given little consideration to any of them except length of staple. There are at present several

hundred varieties planted across the Cotton Belt. In some cases as many as 20 different varieties, no two of which might have the same character or spinning value, are planted in a single community.

Reducing Cost of Production

Yield per acre is influenced by variety, by soil, type and fertility, cultural practices, prevalence of diseases, seasonal factors, etc. Diseases take an average annual toll of about ninety million dollars. Under different conditions, due to variety, soil fertility, climate, cultural practices, and season, the acre yield of cotton varies from a failure to more than two bales per acre. The cost of producing cotton varies in direct proportion to acre yield. <u>The problem, therefore, is to develop</u> through research and breeding <u>varieties</u> and <u>cultural practices</u> that will produce year after year <u>high yields of</u> desired <u>fiber</u> quality and at the <u>lowest cost per pound of lint</u>.

Cotton is the most important agricultural commodity exported from this country. There are more than two million cotton growers and more than ten million farm people, one-third of the total farm population of this country, depending upon cotton for their principal income.

Cotton Quality Must Be Improved

Both domestic and foreign mills in recent years have rather consistently complained about the quality of the cotton produced in this country. In the meantime, improvement in the quality of cotton produced in other parts of the world has resulted because some of the newer foreign developments have been built up on a few of our better varieties and on our more recent improvements in production, harvesting, ginning, and baling. This has naturally given rise to more exacting competition in certain foreign consuming centers.

Our farmers and many of our cotton breeders who have worked with cotton all their lives have failed to keep abreast of modern demands or the increasing competition of artificial fibers. Consequently, all too often in their effort to produce large yields per acre they have disregarded quality factors and have continued to grow a large volume of cotton of mixed varieties which is unsatisfactory for the more exacting manufacturing demands. However, the blame for this cannot be laid entirely to the farmer or the breeder for it is only recently that researches have demonstrated that the variety of cotton grown is the most important single factor in determining spinning value.

Too Many Varieties Planted

The continued planting of a large number of varieties, each of which possesses a different character and utility value has confused the cotton trade and cotton manufacturers and has resulted in general unsatisfactory conditions as to the quality of American cotton. This is in part responsible for the large decrease in exports of cotton from the United States in recent years. The average annual

export for the 5-year period, 1929-30 to 1933-34, was 7,622,217 bales. For the 5-year period 1934-1939, the average exports were 5,027,281 bales. The total 1938-39 exports of cotton were only 3,326,840 bales, or a drop of more than 4,000,000 bales from the average of the 1929-30 to 1933-34 period. At 10 cents a pound, or $50 a bale, this represented a loss in our foreign cotton trade in one year of $200,000,000.

In the meantime, through researches of the Department and the experiment stations and the work of some of the breeders, several high-yielding varieties of superior spinning quality have been produced and are now being grown to a considerable extent in organized one-variety communities in several sections of the Cotton Belt. More than 135,000 farmers who are now growing these improved varieties in one-variety communities have increased their profit on the average of about $6 per acre. As other new and superior varieties are developed and large-scale production of such is attained through standardized production, it is reasonable to expect that the foreign and domestic spinners will seek these cottons in preference to others and that the growers will profit through increased yields and better prices for the superior product.

Increased Yields Cut Production Costs and Permit Better Soil Use

Average yields of lint per acre have increased about 40 pounds in the past four years, but it is reasonable to expect that with more productive varieties, a fuller knowledge of soil fertility and other physiological factors, better rotation and cultural practices, and better and more economical control of cotton diseases, yields can be still further increased with cost of production lowered and profits further increased. The clean cultivated cotton crop favors soil erosion and higher yields makes possible the growing of needed supplies on fewer acres and the use of other crops and practices better suited to erosion control.

Plan and Progress of Work: Work under this appropriation is conducted in cooperation with the State Experiment Stations of North Carolina, South Carolina, Georgia, Florida, Alabama, Tennessee, Mississippi, Arkansas, Louisiana, Oklahoma, Texas, New Mexico, Arizona, and California and the Agricultural Marketing Service of the Department. Certain cotton fiber research cooperative with the Agricultural Marketing Service is located in Washington, but all production and improvement research is conducted cooperatively at the State experiment stations and at three separate Federal field stations in the cotton-growing States. At the State experiment stations the States furnish land, laboratory, and office facilities and a part of the personnel employed on the joint research projects. The program is planned with the State experiment stations as a group so that all cotton improvement and production research for the entire country is one coordinated whole.

How Seed is Increased

The Shafter Acala variety, one of the best bred cottons of the world and now planted on more than one million acres in the Southwest and in Texas and Oklahoma, was developed in this program. During the 5-year period 1928 to 1932 the yield of Acala cotton in the San Joaquin Valley increased from 369 pounds to 423 pounds of lint cotton per acre; during the 5-year period 1933 to 1937 the average increased to 566 pounds of cotton, and in 1938 the average yield for the State of California was 602 pounds. The staple length increased from 1 inch to slightly more than 1-1/16 inches. These increases in yield and quality resulted in an increase of more than $20 per acre annually in the growers' income. While much improved, the variety is not entirely satisfactory in the mill because of neppiness, which can be corrected by further breeding.

Similar work with upland cotton in other areas and with American Egyptian and Sea Island cotton is under way with similar results. The S x P variety of American Egyptian cotton is now in production in the irrigated valleys of Arizona, replacing the Pima variety, which was also developed in this program. The foundation seed stocks being used to reestablish the Sea Island cotton industry in Florida and Georgia came from the Bureau's work. New stocks coming on are still better than those now grown. Improvements in culture and in varieties have also been made in other areas, and there has been marked progress in the control of wilt and seedling diseases.

Standardized Production Pays

Another outstanding result of the Bureau's work has been the organization of single-variety community productions. In 1939, 135,456 farmer members in 1,494 one-variety communities in 495 of the 850 cotton counties in 16 of the 17 cotton States planted 2,969,138 acres, or more than 12 percent of the total United States acreage, and produced 1,618,898 bales of superior quality cotton. The extra return to these grower members over and above what they would have received from the mixed, inferior cotton they formerly grew was $17,000,000. American manufacturers are pleased with the improved quality of the cotton from these areas and are regular customers in those districts where production has reached sufficient volume to attract buyers.

Project 2. Investigations of Fiber Plants Other Than Cotton:

a. Hard Fiber Studies:

Objective: To obtain additional information regarding places in the American Tropics where these fibers can be produced and to furnish cooperative assistance in improving the quality and increasing the production of fiber in places where these industries are already established.

The Problem: To safeguard our future supply of these essential raw materials by the development of additional sources of supply of these fibers in the Western Hemisphere

Significance: The United States consumes annually between 300 and 400 million pounds of abacá, sisal, and henequen and is dependent on foreign countries for its entire supply of these fibers.

Abacá fiber furnishes the raw material for all of the high-grade rope manufactured and used in the United States. This rope is used in practically all of our large industries, particularly for marine purposes. There is no satisfactory substitute for abacá. The entire commercial world production of this fiber is now confined to the Philippine Islands, Sumatra, and Borneo. There is urgent need for the development of a secondary source of supply of abacá in the American Tropics.

Sisal, henequen, and abacá furnish the raw material for our entire supply of binder twine. An adequate supply of binder twine is an essential product in the harvesting of our grain crops. No satisfactory substitutes for these fibers are available. Netherland's India and the colonies of East Africa now furnish about 44 percent of our entire supply of sisal and henequen. The increased production of these fibers in the American Tropics is necessary in order to safeguard our future supply.

Plan and Progress of Work: The plan of the abacá introduction work was to make a preliminary survey of certain regions in the Canal Zone and Panama; to bring propagating material from the Philippine Islands to Panama; and to determine by experimental work (1) whether abacá can be grown satisfactorily in that region, (2) whether the abacá plant is resistant to the diseases which attack the banana plant in Panama, (3) whether fiber of satisfactory quality could be produced, and (4) whether the commercial production of abacá fiber in Panama is practicable. Preliminary experiments answered these questions in the affirmative. Recently, as a result of these findings, some 2,000 acres have been developed as commercial plantings and a small amount of fiber was produced in 1940. Information on sisal and henequen has been collected and supplied to plantation companies and consumers.

b. Fiber-Flax Agronomic and Breeding Investigations:

Objective: To improve methods of producing fiber flax and to breed varieties superior in yield and quality of fiber in order to make possible growing the crop on a profitable basis.

The Problem: Fiber flax has been grown in this country since the earliest times, but it has never been an important commercial crop. Improvements in machinery have taken place in the past 15 years which have lowered the cost of harvesting and preparing the fiber and which take the place of laborious and expensive labor methods that had been in vogue previously for centuries. These open up possibilities of producing the crop in the United States as a profitable enterprise.

Significance: The United States annually imports approximately 5,000 tons of unmanufactured flax fiber valued at about $3,000,000. In addition, we import $25,000,000 to $50,000,000 of manufactured flax

articles annually. Many of these articles could be produced from domestic flax fiber if the American farmer could produce the fiber profitably. Many specialized uses that require the special characteristics of linen--strength and durability--insure a continuing need.

Plan and Progress of Work: The work is conducted cooperatively with the State Agricultural Experiment Stations in Oregon and elsewhere where fiber flax is or can be grown and with commercial flax companies. Field experiments are conducted to determine the adaptation of the crop in different regions and also the best methods of growing the crop. Varieties of fiber flax have been produced which are superior to foreign varieties upon which growers at one time depended.

c. Hemp Investigations:

Objective: To lower production costs and to obtain by breeding a variety of hemp with little or no drug (marihuana) content; to obtain useful information regarding all plant fibers other than cotton that are now used, or that may be used, in the United States; to conduct experimental work with fiber plants that might be grown in this country and on methods of processing the fibers produced by these plants.

The Problem: To have available necessary information regarding plant fibers that are now imported into this country and to establish or increase the production in the United States of fibers that might replace either wholly or in part fibers that are now imported.

There is a growing opposition to the production of hemp in the United States because this plant contains the drug marihuana. Variations in climatic factors are believed to influence the drug content, and the selection of plants especially suitable for the drug production for centuries in Asia has produced a so-called drug type of hemp in contrast to the fiber type and seed type. Hemp seeds from as many sources as possible throughout the world are being collected, and the comparative study of these in the United States is expected to indicate differences in drug yield. Any strain of hemp developed will also have to be suitable for fiber production under the strictly competitive system that has arisen in this country.

Significance: Hemp is one of the oldest crops in this country but has suffered in importance due to the use of cheaper and less desirable substitutes. However, there are demands for this fiber that can hardly be met by other fibers. Hemp and flax are the two most important fibers other than cotton which can be grown and produced economically in the United States. Hemp's chief competitor is jute, which is imported from India and cannot be produced economically in the United States.

The United States imports large quantities of such fibers as jute, kapok, istle, and crin vegetal. Changing conditions in the countries where these fibers are produced materially affect the available supply, quality, and cost of these fibers. Information regarding

these conditions is useful as a measure for the protection of American manufacturers and consumers of the products made from these fibers.

Improvements in fiber machinery or in fiber-cleaning processes not infrequently make it practicable to establish and develop new fiber industries. Jute, ramie, and istle are examples of fiber plants that can be grown in the United States. With improved methods of cleaning and processing, the commercial production of these fibers might be practicable in this country.

There are numerous so-called "new" fibers which are on the borderline of commercial production, an example of which is the "pita floja" of Central and South America. Some of these fibers possess excellent qualities, and with improvements in methods of production and cleaning they may well replace, in part at least, fibers that are now being used.

Plan and Progress of Work: The plan of the work with hemp is to conduct investigations in cooperation with a State agricultural experiment station in a potentially important hemp-growing area to study problems offering the greatest chances of success in accomplishing these objectives with hemp.

Marihuana investigations are closely cooperative with scientific workers in the Bureau of Narcotics, Treasury Department.

Investigations have developed an early maturing strain of hemp for our Northern States. Investigations have aided in the development of the present more economical harvesting machinery and in determining regions in the United States poorly adapted to hemp culture as well as other regions which are well adapted.

Varieties have been studied in regional tests and found to vary in their resin content (the source of marihuana) due to varietal and regional differences and stage of growth.

Information regarding these various fivers has been collected for a period of nearly fifty years from practically all parts of the world. This information has been coordinated and made available for use, and new data are constantly being added. There is a steadily increasing demand from many different sources for information of this character.

Cooperative field experiments both in the growing of miscellaneous fiber plants and in the processing of fibers are conducted both with the State experiment stations and with private individuals and companies.

Field investigations are made from time to time, both in the United States and in foreign countries, of established fiber industries and of new and promising fiber plants and fibers.

(g) DRUG AND RELATED PLANTS

Appropriation Act, 1941	$43,500
Budget Estimate, 1942	48,500
Increase	5,000

PROJECT STATEMENT

Projects	1940	1941 (Estimated)	1942 (Estimated)	Increase
1. Drug, poisonous, insecticide, oil, and related plant investigations	$34,829	$32,555	$37,555	+ $5,000 (1)
2. Hop production and disease investigations	11,159	10,945	10,945	- -
Unobligated balance	1,151	- -	- -	- -
Total appropriation	47,139	43,500	48,500	+ 5,000

INCREASE

(1) An increase of $5,000 is recommended in this item for investigations of plants useful as herbs and spices.

Objective: To determine what herbs and spice-bearing plants are adapted to conditions in the United States and other regions in the Western hemisphere; to breed and select superior varieties and strains; and to develop economical cultural methods.

The Problem: The bulk of the spices and seasonings used in the United States by bakers, confectioners, meat packers, canners and preservers, and other industrial users and in households, hotels, restaurants, etc., is supplied wholly or in part by imports, principally from countries now involved in or affected by war. This means that the normal supply of such materials is drastically curtailed. Moreover, reserve stocks are diminishing at such a rate that great concern is being exhibited on the part of importers, distributors, and users as to the ability of the United States to satisfy its requirements. The problem confronted, therefore, pertains to the possibility of producing adequate supplies of herbs and spices in the United States and in the Western hemisphere, where limited quantities of tropical species are now obtained.

Significance: The Bureau of Foreign and Domestic Commerce, Department of Commerce, in May 1940, reported that in 1939 imports of spices amounted to approximately 150,000,000 pounds, valued at about $15,000,000. Imports in

1939 were somewhat above those of 1935, 1937, and 1938, evidently because of concern over the possible effects of the present war on supplies; but still, in 1936, 150,000,000 pounds were imported, valued at about $13,000,000. Some imported spices are for reshipment, the total exports in 1939 amounting to about 1,500,000 pounds, or one-tenth of the imports.

Imported spices consist chiefly of sage, cinnamon, celery, caraway, ginger root (unprepared or as candied or preserved), cloves, pimento (allspice), paprika, capsicum (red or cayenne peppers), black pepper, white pepper, vanilla beans, tonka beans, marjoram leaves, thyme, curry, mixed spices, crude saffron, turmeric, anise, cardamon, coriander, cummin, fennel, fenugreek, mustard, poppy, cassia (cassia vera and cassia buds), nutmegs, and mace.

The foregoing spices are imported principally from European and Asiatic countries such as France, Germany, Spain, Portugal, Bulgaria, Yugoslavia, Poland, Netherlands, Denmark, Hungary, Roumania, Czecho-Slovakia, Greece, Italy, Belgium, Finland, Norway, Switzerland, Russia, the United Kingdom, China, Japan, Ceylon, Netherlands Indies, French Indo-China, British Malaya, Syria, Morocco, Iran, Iraq, Egypt, Jamaica, Nigeria, Palestine, and Madagascar.

Plan of Work: Seed of various herbs and spices will be collected for cooperative test plantings in various parts of the United States to determine whether the soil and climatic conditions in some sections of this country are favorable for economical commercial production. Studies will be made of the cultural requirements, harvesting, curing, and storage methods conducive to the production of materials most useful for commercial purposes. Many products like vanilla and tonka beans are tropical. Latin American countries might be encouraged to increase their supplies. We should be in position, when requested, to give them technical advice and assistance on these products.

The increase requested would provide for additional temporary personnel, supplies, materials, travel, and equipment necessary for the effective prosecution of the work.

WORK UNDER THIS APPROPRIATION

General: The work under this appropriation is concerned with the investigation, testing, and improvement of plants yielding drugs, poisons, perfumes, spices, oils, insecticides, tannin, and hops. The work is divided along the following lines of activity:

Project 1. Drug, Poisonous, Insecticide, Oil, and Related Plant Investigations:

Objective: To determine the agricultural possibilities in the United States of plants the products of which constitute the raw materials for medicines, flavors, perfumes, paint and varnish oils, insecticides, tannin, and related commodities; and to supply as far as practicable facts and materials useful in developing domestic commercial production of these plants.

The Problem: The industries in the United States which manufacture medicines, perfumes, flavoring extracts, paints, varnishes, linoleum and related products, insecticides, and leather are dependent to a very large degree on foreign

sources for the plant materials that go into their manufactured products. These materials come from wild and cultivated plants in many parts of the world, in some cases from remote regions. Their production, often without organization and control, is attended by wide fluctuations in supply and quality. In periods of world disturbance their procurement is frequently difficult, if not impossible, and their cost at such times usually is out of proportion to their intrinsic value.

Some of the plants from which these materials may be obtained have been introduced into the United States and found adapted to growing conditions in some sections of this country. It is known also that some plants native to the United States are potential sources of certain of these materials, as rotenone from devil's shoestring and tannin from sumac and canaigre. But the cultural and production requirements of this group of plants are not yet well enough known or their management with respect to harvesting, processing, etc., not yet sufficiently understood to warrant their use as crops by American farmers.

Significance: The insecticide pyrethrum, if it could be produced successfully on a commercial scale in this country, would require approximately 50,000 acres to provide the present amount annually imported. The rotenone now used annually in the United States (about 14,000,000 pounds of dusting material) would require the domestic production of a large acreage of devil's shoestring on the poorer sandy soils of the South. Because chestnut wood, the principal domestic source of tannin, is rapidly being exhausted due to chestnut blight, new domestic sources of tannin are urgent. About half of the domestic consumption of tannin, or 50,000 tons, is now imported. The most promising sources are canaigre and sumac, about 50,000 acres of which would be required to offset present importations. A similar situation obtains with respect to other plants of the group with which these investigations are concerned.

If adequate information can be developed to indicate to what extent these plants can be established as crops in this country and made reasonably profitable, the industries concerned will be provided with more dependable sources of raw materials of better and more uniform quality. More important, however, would be the effect on our agricultural economy in that such new crops would help to further land-utilization, crop-diversification, and soil-conservation programs, aid in reducing unemployment in farm populations, and provide cash crops entirely non-competitive with established crops and, therefore, in a measure reduce crop surpluses.

The medicinal plants would, on the whole, fit best into the northern and some of the Pacific Coast States, particularly on small farms. Safflower, a drying-oil seed crop, is adapted to the northern Great Plains and to irrigated areas in California and the Southwest; devil's shoestring, an insecticide plant is native to the poorer sandy soils of the Southeast and Texas; and the castor bean plant is adapted to even wider areas in the same region. Among the tannin plants canaigre prefers sandy soil in central and southern Texas and New Mexico, and the sumacs are adapted to most of the Eastern and Mississippi Valley States.

Plan and Progress of Work: The work involves three distinct phases-- (1) field work, including all studies pertaining to propagation, culture, harvesting, curing, distillation and other processing, yields, and production costs; (2) laboratory examination of materials obtained to determine their quality and the relation of various conditions and practices to quality; and (3) development through selection and breeding of varieties and types of superior quality and greater disease resistance. The first-mentioned work and most of the selection and breeding work is conducted at Bureau of Plant Industry field stations and through cooperation at State experiment stations. Since many species are involved adapted to a wide range of conditions, the field work must be done in numerous locations at times widely separated. This requires considerable travel of project leaders to coordinate properly the work of assistants, cooperators, and laboratory workers.

Cultural tests of many species of plants yielding drugs are continuously under way and the adaptation of many to specific areas have been determined. Such information is, therefore, available regarding such important drug plants as belladonna, digitalis, henbane, and the opium poppy. More extensive field studies of essential oil plants important to the flavoring and perfume industries are under way to determine the effects of various factors on yield and quality. Drying-oil seed crops yielding drying oils for the paint and varnish industry, such as safflower, perilla, and others, are grown experimentally in various sections. The possibilities of growing pyrethrum, an important insecticide, are being determined and attempts to develop more toxic and disease-resistant strains are in progress. A machine for economically harvesting this crop has been developed. A native species of Tephrosia, containing rotenone, a widely used insecticide, is under investigation in Texas to determine its crop possibilities in the South. Two native species containing tannin in substantial amounts, namely, canaigre and sumac, are being studied with a view to establishing them as crops to augment the dwindling domestic supply of tannin materials.

Much of the field work on the above projects is conducted at Arlington Experiment Farm, Virginia, and Beltsville, Maryland, but some of the work on insecticide and tannin plants is located at College Station, Texas, and other Southern and Southwestern points. The annual expenditure for this field work is about $6,500. Cooperative experiments elsewhere are generally conducted at very small cost. Collaboration of the Bureau of Entomology and Plant Quarantine on certain phases of the insecticide plant investigations involves an expenditure of about $1,000 a year.

Project 2. Hop Production and Disease Investigations:

Objective: (1) To determine the nature, occurrence, dissemination, and practical field control of downy mildew and other hop diseases; (2) to develop through selection and breeding varieties that are resistant to such diseases and that produce higher yields of hops of superior brewing qualities; (3) to investigate the relation of the composition of hops to their value in brewing and the relation of various production

and handling practices to such value; (4) to develop standards of quality as a basis for more rational methods of marketing.

<u>The Problem</u>: In the past 10 years the American hop grower has encountered serious trouble in the losses caused by downy mildew in Oregon, western Washington, and some parts of California and New York. The rapid spread of the disease and its great destructiveness under favorable conditions make hop growing in the regions mentioned precarious. Known practical field control measures add considerably to production costs, which are already high. The problem, therefore, calls for cheaper control measures or the introduction or development of immune or resistant varieties that are also more productive and have some of the qualities of the European varieties favored by brewers. Since the quality of hops is affected by various practices in connection with the culture, harvesting, curing, baling, and storing of the crop, it is important to determine the degree and importance of this relationship. Virus diseases are also becoming more of a problem each year.

<u>Significance</u>: The American hop crop has a market value of about $10,000,000 annually. American brewers import annually from 6 to 8 million pounds of European hops, which they claim are superior to those produced domestically and for which they pay a much higher price. If the domestic crop can be improved through introduction or development of new varieties which are not only disease-resistant but compare in quality with the preferred European type, the domestic production could be increased by the amount of these imports, thus providing for an additional 6,000 to 8,000 acres. The production of superior types, including seedless hops, will benefit the brewing industry in providing a raw material more uniform in quality and of higher brewing value.

<u>Plan and Progress of Work</u>: The investigation of hop disease problems, field control measures, and the breeding work are centered at Corvallis, Oregon, and conducted in cooperation with the Oregon Agricultural Experiment Station, with close collaboration with growers and county agents elsewhere in the State and in California and Washington. Three experimental hop yards totaling 7 acres are maintained for the purpose and greenhouse and laboratory studies are conducted in connection with the field work. Practical means of controlling hop mildew under various conditions are studied and information on these made available to growers. Development of resistant varieties possessing good qualities for brewing is in progress and several promising sorts will soon be ready for extensive tests. Other disease problems of the crop will require increaseing attention. The investigations at Corvallis are conducted at an annual cost of about $9,500, exclusive of the amount for necessary analytical work, which is done in the Washington laboratories.

The hop quality studies are developing information required to establish much needed hop standards and have resulted in a better understanding of the relation of some cultural practices to quality. Similar information concerning the effects of drying, baling, and storage practices needs to be obtained.

(h) DRY-LAND AGRICULTURE

Appropriation Act, 1941 .... $226,828
Budget Estimate, 1942 226,828

PROJECT STATEMENT

Projects	1940	1941 (Estimated)	1942 (Estimated)
1. Dry-land agricultural investigations:			
(a) Dry-land field crop production investigations	$159,027	$159,862	$159,862
(b) Dry-land fruit and vegetable production investigations	28,182	28,277	28,277
(c) Cooperative farm windbreak demonstrations and experimental test plantings	23,604	23,689	23,689
(d) Regrassing investigations in dry-land areas	14,995	15,000	15,000
Unobligated balance	1,020	- -	- -
Total appropriation	226,828	226,828	226,828

WORK UNDER THIS APPROPRIATION

General. The work under this appropriation is concerned with investigations at field stations on the agricultural possibilities of the Great Plains and Intermountain regions.

Project 1. Dry-Land Agriculture Investigations:

Objective: To conduct studies on (1) crop cultural and production methods, including crop rotations; (2) the storage and use of soil moisture; and (3) the development of windbreaks and home orchards and gardens under the prevailing semiarid climatic conditions. These studies are directed toward the stabilization of agriculture in the region and the determination of the relationships that may profitably exist between the growing of crops and the growing and utilization of grass in livestock production.

The Problem: The study of dry-land agriculture problems was begun in a systematic way by the Department in 1905 to meet the urgent needs of settlers who were taking up the land in the Great Plains. Most of them

were from humid areas and knew nothing of farming under dry-land conditions. Failure and tragedy were common and recurrent as wave after wave of settlement advanced and receded. Misinformation on climate and methods of farming was the rule, and no one understood the principles underlying the handling of the soils and growing of the crops. The State agricultural colleges already had been located either east or west of the Plains proper and the States were financially unable to conduct the necessary experiments and to establish the required experiment stations in the region. Furthermore, it appeared that the Government, which had opened up the land for settlement, had a responsibility to meet the need of these settlers.

In order to obtain information, a series of stations was established, some in cooperation with States, a few independently, covering the Great Plains from north to south and east to west, where studies could be made of rotations and tillage methods, how to handle the soil in order to conserve and utilize moisture, what crops and what varieties of crops to grow, how best to utilize the pastures, where it was safe to farm and where not, and other problems of importance in establishing a stabilized system of agriculture in the region. These stations were established and have been maintained primarily for the research work of the Division of Dry-Land Agriculture to which for administrative purposes they have been assigned; but facilities are provided also for work which is cooperative with various other Divisions of the Bureau, such as Cereal Crops and Diseases, Forage Crops and Diseases, and Fruit and Vegetable Crops and Diseases.

Incident to the progress of work with field crops, attention has been directed also to fruits and vegetables suitable to Plains conditions, as well as to trees and shrubs adapted for use in windbreaks and for ornamental purposes. More recently experiments in cooperation with other agencies in the Department and in the States have been undertaken to determine ways and means of regrassing abandoned farm land on depleted ranges and to determine the place of grass in dry-land farming practice.

Plan and Progress of Work: The investigations are conducted, generally in cooperation with the State experiment stations or with other divisions of the Department, at (1) field stations maintained by this Division at Akron, Colorado, Tucumcari, New Mexico, Mandan, North Dakota, Lawton, Oklahoma, Woodward, Oklahoma, Big Spring, Texas, Dalhart, Texas, and Sheridan, Wyoming; (2) field stations maintained by the Division of Irrigation Agriculture at Huntley, Montana, and Newell, South Dakota; and (3) State substations at Colby, Kansas, Garden City, Kansas, Hays, Kansas, Havre, Montana, Moccasin, Montana, Dickinson, North Dakota, North Platte, Nebraska, Pendleton, Oregon, and Archer, Wyoming.

These dry-land stations form almost the entire agricultural research facilities for this vast region of one-fifth of the United States. They provide facilities for the work of the Division of Dry-Land Agriculture and for cooperative work by States and other divisions and bureaus of the Department. The activities of these several agencies

are arranged to avoid duplication and competition and so that they serve each to supplement the other. This coordination and the continuity of effort that has been attained throughout the region have been due to Federal participation. Some unusual accomplishments have resulted; among them the following:

Development and introduction into general use of crested wheat-grass; the creation of dwarf grain sorghums, combine type milo, disease-resistant milo, and early grain sorghums that extend the crop north through Colorado, Nebraska, and South Dakota; the breeding of varieties of tomatoes better adapted to the Great Plains than any before available; the creation of new hardy fruits, especially plums and apples.

Other work has resulted in determining (1) the varieties of trees, shrubs, and vines that can be successfully grown under the extremely trying conditions of the Plains; (2) that the carrying capacity of pastures can be increased without injuring the vegetation by grazing them in rotation; (3) the relations between annual and seasonal precipitation and yield that are of basic importance in determining the use to which land should be put; (4) that definite relations exist between the depth to which the soil is wet at seeding time and the yields of spring and winter wheat, by which farmers may avoid many failures and greatly increase their chances of success; (5) the value of early preparation to conserve moisture in the hard red winter wheat belt; (6) the place of summer fallow in the cropping system of the Great Plains and the best methods of conducting an effective fallow; (7) the value of cultivated feed crops in the rotation to increase production and diversify the agriculture; and (8) the value of such home-grown crops as milo and proso for finish-feeding the livestock grown on Plains pastures. In spite of such accomplishments, however, much remains to be done in further developing cultural methods and crop sequences to maintain soil productivity, prevent erosion, and insure stability and certainty of production.

Field Crops Investigations

Storage of moisture in the soil and its efficient use are basic objectives. Rotation and tillage experiments and soil-moisture studies are conducted on field plots with wheat, the chief crop in the area, oats, barley, sorghums, corn, and other cereals, forage crops, and cotton. Yields are secured annually from nearly 4,000 plots, on which all adapted crops are grown in many sequences and combinations and by many different methods of culture. Meteorological data taken close to the fields upon which the crops are grown afford a sound basis for study of the relations between crop yields and climatic factors. Many of these experiments supply data of continual current usefulness and must be carried on from year to year.

Work conducted at these field stations on the relationship of soil moisture at seeding time to wheat yields has influenced or determined loaning policies of the Farm Credit Administration and the Farm Security

Administration. It has guided regulations of the Agricultural Adjustment Administration in adjustment programs and is being used by county and State planning boards in formulating their programs. Data on climate and yields have been largely utilized by the Federal Crop Insurance agency in determining rates for crop insurance in the region. The Soil Conservation Service makes continual use of the experimental data on methods of culture effective in saving water and preventing erosion in developing action programs on its many projects in the region. Special problems are connected with varietal adaptation, cropping limitations, controlling weed growth, preventing erosion by wind and water, and the relation of tillage to nitrification and the storage of nitrates. With changing conditions of cropping and season, new problems are constantly arising in regard to all these items which need further attention.

Fruits and Vegetables for Dry-Land Areas

The dry-land region lacks home-grown fruits and vegetables and information on their production. It is not now and is not suited to become surplus producing in fruit and vegetable crops. Work under this project is directed to determining the feasibility and methods of growing needed fruits and vegetables for home use and to developing adapted varieties. Some notable improvements have been made in varieties better adapted to the dry lands and in developing methods of production with windbreak protection and by means of cultural and rotation methods.

Investigations at dry-land stations in the southern Plains have shown that setting of tomato fruits, which is often poor in dry seasons, may be materially increased by the application of fertilizers to the soil. These stations have determined also that grapes are a very successful fruit crop, even in the driest sections, and the only long-lived fruit yet found that is successful there.

Farm Windbreak Demonstrations

Experiments are conducted on farmstead windbreaks in the northern and southern sections of the Great Plains west of the area of the Prairie States Forestry Project. Basic data are collected, at field stations and on farms selected to represent a wide range of soil types and climatic conditions, on methods of tree and shrub planting and success of plantings, root development on different soils, species best suited for various types of soil and in different areas, and soil moisture in plantings under different soil-management and farm-management practices.

About 6 million trees have been produced in station nurseries and used in these experiments on stations and with several thousand cooperating farmers since the work was started at Mandan, North Dakota, in 1914, and at Woodward, Oklahoma, in 1930. Several thousand species of plants, both native and foreign, have been tested at stations to determine their adaptation and their suitability for use in windbreaks and as ornamentals. Many of these have proved worthy and have been

distributed. The results of these tests have been utilized widely by the Soil Conservation Service in operations in the dry-land area and in the Great Plains farm windbreak operations. To these activities the dry-land station data have been basic.

Windbreaks serve a very practical purpose in protecting the home, farm buildings, the kitchen garden, and fruit and ornamental plantings from soil-blowing and excessive evaporation. They are often useful in protecting farmyards from drifting snow and in collecting snow in garden and fruit-growing plots, with beneficial effects on the supply of soil moisture. Also they afford a pleasing ornamentation to the farmsteads in the prairie country. With increased age, however, new problems are arising in maintaining such plantings and these need investigation.

Regrassing Investigations

The use of grasses and sod crops in rotations appears desirable but under dry-land conditions is beset with many unusual difficulties. Many of the relations of sod to cropping practices remain to be determined, such as the possibilities of interchange of sod and cultivated crops, the effect on the soil of sod in the rotation, its effect on storage of moisture, and the ultimate effects of these on crop production. The Soil Conservation Service, Farm Security Administration, and the AAA have been utilizing available information on grass in their operations but are in urgent need of much additional information to effectuate their programs. This activity is directed to answering these fundamental problems.

Appropriations for regrassing experiments are used in part to support investigations in cooperation with other divisions of the Department and with the State of Oklahoma on 4,720 acres recently purchased for this purpose. About 1,200 acres will be used to test and demonstrate methods of reseeding on cultivated land. Many varieties will be used for determining their adaptation, palatability, and carrying capacity. The remainder of the land will be used for grazing tests to determine best methods of pasture management. The place of grass in crop agriculture must also be determined.

The practicability of destroying sage and other noxious perennial plants by mowing has been demonstrated, and thousands of acres are being mowed by ranchers near Woodward, Oklahoma. Other methods of reestablishing grass on land now occupied by aggressive native shrubs of little value are promising avenues for experimentation.

(i) EXPERIMENTAL GREENHOUSE MAINTENANCE

The work under this appropriation, for which $77,372 was provided in the 1941 Act, is consolidated in the estimates for 1942 with the item "Fruit and Vegetable Crops and Diseases".

(j) FERTILIZER INVESTIGATIONS

The work under this item, for which $240,000 was provided in the 1941 Act, is consolidated in the estimates for 1942 under the new appropriation title "Soil and Fertilizer Investigations".

(k) FORAGE CROPS AND DISEASES

Appropriation Act, 1941 ....$300,000
Budget Estimate, 1942................. 300,000

PROJECT STATEMENT

Projects	1940	1941 (Estimated)	1942 (Estimated)
1. Alfalfa investigations..........	$62,334	$59,778	$59,778
2. Clover investigations...........	28,253	26,821	26,821
3. Soybean investigations..........	18,688	17,572	17,572
4. Lespedeza, cowpea, and miscellaneous legume investigations............................	39,417	36,302	36,302
5. Grass investigations............	161,848	159,527	159,527
Unobligated balance................	2,910	- -	- -
Total appropriation.........	313,450	300,000	300,000

WORK UNDER THIS APPROPRIATION

General. The work under this appropriation is concerned with (1) the improvement of cultural and management practices with forage crops; (2) selection and breeding of varieties of forage plants best suited to various soil and climatic conditions, capable of withstanding extremes of heat and cold, and resistant to drought, diseases, or insect injuries; (3) studies of the factors underlying the development of disease epidemics on forage plants, and development of control measures by selection and breeding for resistance, improved cultural practices, or otherwise; and (4) limited investigations of turf problems. The work is divided along the following lines of activity:

Project 1. Alfalfa Investigations:

Objective: To increase returns to alfalfa growers through improved cultural practices and selection and development of varieties better adapted to unfavorable environment and resistant to insects and diseases.

The Problem and its Significance: In recent years certain diseases and insect pests have become an increasingly serious menace to alfalfa production, with the result that in many cases stands survive only 2 to 4 years where alfalfa formerly produced satisfactorily for 10 or more years. The selection and breeding of alfalfa strains resistant to diseases and insect injuries and adapted to various soil and climatic

conditions offers a means of lengthening the productive life of alfalfa stands and minimizing the losses now suffered by the growers. Cultural, management, and disease factors are all interrelated with this improvement problem, and a simultaneous attack upon these is necessary to assure progress in the selection and breeding program.

Nearly 14,000,000 acres of alfalfa were grown in the United States in 1938. The 29,000,000 tons of alfalfa hay produced were valued at $290,000,000. The alfalfa seed crop of 1937 was valued at $13,000,000. The 1938 acreage exceeded that of 1928 by 2,500,000 acres. This increase in acreage, induced by broad adjustment and soil-conservation programs, was made possible by facts accumulated from long and continued research of the type done under this project.

Bacterial Wilt

Further extension of acreage and the successful maintenance of profitable stands on existing acreages are beset with increasing difficulties among which destructive diseases are of special importance. The most widespread disease is bacterial wilt, which destroys stands in from 2 to 4 years in areas where alfalfa formerly would last 10 years of more. This necessitates more frequent reseeding and, because of the greater cost involved, further reduces net returns. Other diseases, faulty cultural and management practices, and the use of unadapted, unimproved varieties are additional factors in keeping farmers from obtaining a maximum return from the funds invested in alfalfa growing. Solution of the disease and other problems that are responsible for short periods of stand survival, lowered yields, and reduced nutritive value of the alfalfa hay and pasturage would result in savings to farmers amounting to millions of dollars each year.

<u>Plan and Progress of Work</u>: The work is conducted in cooperation with the States in the principal alfalfa-growing areas. Work is under way in North Carolina, Georgia, Mississippi, Texas, Oklahoma, Kansas, Nebraska, Iowa, Wisconsin, Utah, Nevada, and Arizona, and through a regional coordination practically all alfalfa work in the country is organized as one unit program. Strains of alfalfa resistant to bacterial wilt have been developed and are being tested widely. Plans are progressing to develop adequate seed supplies and get them into commercial production. Seed yields which have declined during the past decade, due to flower injury by Lygus bugs and other unknown factors, have limited wider use of alfalfa in soil-conservation practices. Certain cultural practices have been developed to aid in the control of these insects, but a Lygus-resistant alfalfa is needed. Tests of alfalfas from both foreign and domestic sources are being carried on to determine those best suited to various soil and climatic conditions and their relative resistance or susceptibility to diseases and insect injuries. Cultural and production investigations are in progress to determine the effect of environmental factors and management practices upon the yield and composition of alfalfa hay and pasturage.

Project 2. Clover Investigations:

Objective: To improve clovers in order to reduce the hazards of climate, diseases, and insects in growing clovers for the profitable production of livestock and as cash crops and for conserving the soil.

The Problem and its Significance: Failure to obtain and maintain productive stands of clovers annually results in large loss to the farmer in price of wasted seed, use of land, purchase of needed feed, and loss of soil productivity through inability to maintain desirable legume rotations. Losses in stands of clover frequently blamed on the weather are in reality often caused by soil deficiencies, improper cultural treatment, diseases, or lack of adaptation of the plant to the environment. The problem is (1) to develop successful methods for insuring stands; (2) improve clovers by breeding and selection for winter hardiness, resistance to drought, diseases and insects, increased palatability, and ability to tolerate grass competition and unfavorable soil conditions; and (3) determine methods for controlling clover diseases and breeding clovers resistant to disease.

The annual farm value of red, sweet, and alsike clover hay and seed approximates $275,000,000. This does not include their value for pasture and in maintaining soil fertility and the additional value of other clovers for which statistics are not available. Twelve important clovers are basic crops in one or more regions of the United States, while others are important under specific conditions in certain areas. This group of crop plants is one of the most important elements in any permanent system of agriculture or soil conservation.

Plan and Progress of Work: This work is conducted cooperatively with the State agricultural experiment stations in the clover-growing areas.

Red Clover: Certain foreign and domestic strains of red clover have been found to be unadapted in the principal red-clover belt. Recently developed superior stocks for the central and southern parts of the red-clover belt, respectively, are being increased for growing on farms. Breeding to develop high yield, disease resistance, and winter-hardiness is in progress. Resistance to mildew and southern anthracnose is being attained.

Sweetclover: Breeding operations are under way to produce later maturing varieties for pasture, leafy and small stemmed varieties for hay, and rank-growing varieties for soil improvement. Diseases which reduce stands in the spring of the second year are being studied. Since the coumarin content of sweetclover is related to the toxicity of spoiled hay, efforts are being made to breed strains low in or free from coumarin.

Miscellaneous clovers: Strawberry clover, important in the reclamation of seeped, alkaline soils of the Western States, is being studied to determine its range of salt tolerance. In the Southern and Pacific States winter annual species --crimson, Persian, hop, cluster, and subterranean--give promise for soil conservation and livestock programs. Preliminary experiments indicate that grass competition at seedling emergence and lack of available phosphoric acid are two of many factors responsible for failures. There is need for studying the problems of white clover, a type important in pastures and lawns but spasmodic in occurrence, being abundant some years and absent others.

Project 3. Soybean Investigations:

Objective: (1) To improve cultural, production, and management practices for growing soybeans; (2) to develop through introduction, selection, and hybridization strains of soybeans superior in quality and yield for forage, food, and industrial uses; and (3) to develop methods for controlling the diseases of soybeans.

The Problem and its Significance: With increased utilization of soybeans there is demand from farm, industrial, and food interests for the development of forage, grain, and edible varieties of superior quality. This demand comes from regions now growing soybeans extensively, as well as from the Southern, Southwestern, and Northern States where there is need for varieties for a wider range of conditions and uses than present types provide. Varieties having high oil content, high protein content, high and low iodine number, non-shattering characters, high seed yield, and disease resistance are especially desired.

Within the past decade the soybean has assumed a place of major importance in the agricultural, food, and manufacturing industries of the United States. During the past 5 years the American crop has increasingly competed with the Manchurian product in the European market. Total soybean acreage has increased for 3-1/4 million acres in 1930 to more than 10 million acres in 1939, and annual production from 14 million bushels to more than 90 million bushels during the same period. The value of the crop for all purposes in 1939 is estimated at more than $125,000,000. More than 200 oil mills and food and industrial establishments consume about 70 percent of the annual seed production. Oil mills engaged in processing the beans for oil and meal alone have a crushing capacity of more than 75,000,000 bushels. Oil mills and food and industrial plants are increasing in various sections of the soybean region.

Plan and Progress of Work: Since 1898 more than 10,000 seed lots of soybeans have been collected from various regions of the world, chiefly oriental countries. These introductions have shown wide variation in soil and climatic adaptations, size, shape, color, and composition of seed, and suitability for different uses, as well as considerable variation in plant characters.

Extensive studies with these introductions and selections from them have been and are being carried on with experiment stations and special cooperators in nearly all States, Alaska, Puerto Rico, Hawaii, and the Philippines. Many of these introductions and selections have given outstanding results and are constantly replacing old standard varieties. At present more than 100 named varieties are handled by domestic growers and seedsmen, most of which are the result of introduction and selection by the Department of Agriculture.

Chemical-composition studies of the seed are conducted along with the breeding work. Analyses are made of introductions and selections grown under the same and under different environmental conditions. Varieties, introductions, and selections thus far range from 12 to 27 percent oil, 28 to 56 percent protein, and 118 to 143 in iodine number (drying quality of oil). Considerable variation is also found in lecithin, sugars, starch, and the different amino acids.

Cooperative work with departments of home economics (Federal and State) show wide differences in the flavor and cooking quality of soybean varieties. Many of these varieties are on the market and are especially valuable as green vegetable beans, dry edible beans, flour, salted roasted beans, bean milk, bean sprouts, and bean curd. Several of the most promising introductions and selections especially suitable for use as forage, green or edible beans, or beans of high oil and protein content are being increased for more extensive distribution.

Although the development of new varieties has been largely by selection, hybridization of wild types with cultivated varieties is in progress. Investigations, looking to the improvement of cultural, production, and management practices are being carried on, including studies on the time of planting, harvesting, crop rotation, etc. Studies have shown the composition of seed and plants to vary markedly under different cultural and harvesting conditions.

Most varieties of soybeans shatter their seed badly before harvest, thus resulting in serious losses to growers. Considerable progress has been made in developing non-shattering varieties that are desirable in other respects.

Although the soybean has been relatively free from serious epidemics of disease, there are several bacterial and fungous diseases of the soybean that occur in this country which constitute a constant menace to the crop. Preliminary studies are being made of the various diseases, their causal organisms, and possible means of control. Breeding for disease resistance has been found an important factor, since studies indicate that varieties differ markedly in relative resistance to several of the more important diseases.

Project 4. Lespedeza, Cowpea, and Miscellaneous Legume Investigations:

Objective: To increase the usefulness of lespedeza, cowpeas, and miscellaneous legumes through (1) improved cultural practices and (2) development of improved strains and varieties better adapted to specific localities and resistant to diseases.

The Problem and its Significance: Nearly 30 million acres in the United States are planted to lespedeza, cowpeas, velvetbeans, burclover, vetches, fieldpeas, crotalaria, and kudzu. Full utilization of these crops is limited by lack of knowledge concerning adaptation, seed production, and disease control. Some of the more urgent needs are: (1) winter legumes for the South that are winterhardy, disease-resistant, and good seed producers; (2) control measures for the bacterial wilt of lespedeza, a new disease that threatens this important crop and that has already been reported in 7 States; (3) strains of perennial lespedeza with low tannin content for grazing; and (4) adapted legumes for pastures and open fields in many sections where a legume is needed for growing with grass to furnish better livestock feed and aid in the prevention of soil erosion.

In the past 15 years lespedeza has become one of the major forage crops of the country. No other crop of anything like equal importance has received so little attention with respect to improvement of varieties, control of diseases, and cultural methods. The little work that has been done with lespedeza has resulted in higher-yielding strains and varieties adapted farther north than the original varieties. However, further improvement of varieties and a study of their adaptation to different areas and conditions are necessary for most economical production.

Perennial Lespedeza

Sericea lespedeza is well adapted to poor acid soils over a wide territory and is a perennial legume that stands more drought periods than any legume having economic possibilities as forage. It is a good erosion-control plant and one of our best crops for soil improvement. This legume, however, has a very high tannin content which limits its use as forage. Furthermore, its cultural requirements are not sufficiently well known to enable growers to have uniform success in obtaining and maintaining stands. If a strain of sericea low in tannin were developed and cultural requirements more definitely determined, this crop would then be to the eastern United States what alfalfa is to the West, and its use over a wide area would be assured. At present sericea is being used to some extent but plantings are limited to a few thousand acres.

In the past few years a wilt disease has been discovered on lespedeza and in some instances has done serious damage. Studies already completed show this disease to be new to science but no work on control measures has yet been undertaken. Other diseases are

known to attack lespedeza in this and foreign countries and these diseases need study.

Cover Crops Tie the Soil Down

The current realization of the value of cover crops for erosion control and soil improvement has emphasized the importance and need for improved cover crops adapted to the varied climatic and soil conditions found in different parts of the United States. For many sections adapted and adequate crops are not available and best methods of handling the crops now available have not been determined.

In the southeastern United States winter crops that will mature in that area are sorely needed to make home production of seed possible and to lower costs. Thus far, in most sections crops that give best winter growth will not produce a good seed crop locally. Summer annual legumes, such as crotalaria, alyceclover, sesbania, and velvetbeans, are available, but the most economical way of handling these as cover and soil-improving crops has not been adequately determined. In the more northern latitudes and in the western United States soil-improving crops have not been given adequate attention, and the possibilities in their use need to be much more definitely determined. What is most needed in connection with a cover crop for soil improvement is a determination of the types best suited to the soil and climatic conditions of the region to be served or the development of improved strains for such purpose; the determination of the most effective or efficient way of handling and utilization of the cover crop to insure most economical production of the cash crop it is to benefit, as well as preservation of soil fertility; and the development of adapted crops of which seed can be produced on the farm where it is to be used.

The need of legumes for supplementing grass as a cover for maintaining soil fertility, preventing erosion, and supplying improved pasturage is a major problem in most pasture areas and especially so in the southeastern United States. Some of the legumes available partially fulfill this need, but a study of the large list of available winter and summer legumes to determine by what cultural means, if any, they can be maintained and utilized is the most likely way of solving this problem. Crops that need to be studied especially in this connection are alyceclover, hirsute indigo, supina beggarweed, and crotalaria as summer crops and the burclovers, narrowleaf vetch, roughpeas, and the true clovers as winter growing crops.

The acreages of the major crops covered by this project, according to best available statistics and estimates, are approximately as follows:

Lespedeza........	15,000,000 acres	Vetches......	1,000,000 acres
Cowpeas..........	7,000,000 "	Fieldpeas....	1,000,000 "
Velvetbeans......	2,500,000 "	Crotalaria...	100,000 "
Burclover........	2,000,000 "	Kudzu........	25,000 "

Plan and Progress of Work: Major phases of the work are carried on in cooperation with State agricultural experiment stations in various parts of the country. Related studies of a less intensive nature are carried on at certain Federal field stations or State substations. Information on improved cultural practices for lespedeza, crotalaria, alyceclover, Hungarian vetch, and other miscellaneous legumes has been collected. Improved strains of lespedeza and crotalaria have been introduced resulting in larger yields and extending the region in which these crops can be grown. Information on the adaptation of cover crop varieties for various parts of the country has aided the development of the soil-conservation program. Increasing soil fertility and the use of short rotations greatly lessens damage from fieldpea diseases.

Project 5. Grass Investigations:

Objective: To provide facts and materials useful in restoring, maintaining, improving and utilizing grass as a basic farm crop in order to improve farm income; conserve and improve soil; provide cheaper and more abundant high quality forage for livestock; help adjust the shift from surplus soil-depleting crops to soil-conserving crops, and aid in the improvement of turf for lawns, airports, and recreational use.

The Problem and its Significance: The past history of land use in the United States has been to destroy grass to make room for cultivated crops. Now changing social and economic conditions emphasize the value of grass in a system of permanent agriculture. Only within recent years has the United States become conscious of the value of grass and the part it can play in contributing to the solution of current agricultural needs. Numerous problems have presented themselves in the efforts to restore grass and new problems continue to arise, all of which are demanding attention. One of the major problems is the lack of fundamental knowledge concerning the wide variation between individual plants within a given species. This knowledge is basic to improvement work necessary to the full utilization of grass as a farm crop. Some of the better grasses for certain regions have poor seed habits, which makes it expensive to get them started. Others are well adapted but are low in feed value or are unpalatable. Many grasses are subject to diseases.

When it is considered that at least 150 different species of grasses may have definite pasture or hay value, not to mention the large number of strains within each species, one can readily see the tremendous field that is to be studied and the problems arising. It is important to realize that each species represents a field of research comparable to that carried on for such other crops as oats, wheat, rye, alfalfa, soybeans, etc.

According to the 1934 census there were 1,054,515,111 acres in farm land in the United States. Of this there were 98,579,083 acres or 9.3 percent in plowable pasture land; 108,095,711 acres or

10.3 percent in woodland pasture land; and 311,225,652 acres or 29.5 percent of other pasture or range land. This gives a total of 49.1 percent of total farm land in pastures.

Approximately 25,000,000 acres of hay and pasture land are reseeded each year, while there are approximately 100,000,000 acres of land that should be seeded down to remain in pasture or range land. Grass is the principal component of pasturage and also supplies about one-third of the national hay crop. Grass is also of the utmost importance in erosion control, watershed protection, and soil conservation. Grass, in other words, is basic to the agriculture of America.

Soil and climatic conditions vary widely throughout the country. Within this complex there are six fairly well defined regions each with its distinctive problems: (a) Northeastern and Central, (b) Southeastern, (c) Great Plains, (d) Intermountain, (e) North Pacific Coast, and (f) South Pacific Coast. Each region demands a distinctive attack on its particular problems.

While work on grazing-management studies on public and privately owned range lands are the responsibility of the Forest Service, the problems of (1) improving species, (2) methods of artificial seedings, (3) seed production, and (4) disease control of grasses on range lands are the responsibility of this project. A reduction in productivity of range lands caused by unfavorable climatic conditions during the past decade and the vast increase in the action programs for soil conservation has placed increasing demands on this project.

<u>Plan and Progress of Work</u>: Since 1935 this work has been carried on at 26 locations in 23 States, dividing the work into the important agricultural grass regions as previously indicated. The cultural and production investigations with hay and pasture grasses are supported in all regions by breeding and improvement work and disease studies, although, for obvious reasons, the species of the Southeastern States are different from those in the Northeastern States, which, in turn, differ from those of the Great Plains, and so on. In the Northeastern States work under this project is closely coordinated with that of the U. S. Regional Pasture Research Laboratory and 12 States cooperating. In all regions the work is in cooperation with State experiment stations, Soil Conservation Service, Forest Service, and other Federal agencies or bureaus.

Progress has been made in methods of establishing permanent pastures in the humid East and in the southern Plains region. In the latter region preliminary studies indicate that native and introduced grasses can be established on Sudan or sorghum stubble mulch, although considerably more work is necessary to determine the effect of different soil types, degrees of slope, exposure, etc., in their influence on establishment. Two early Department of Agriculture introductions, Sudan grass and crested wheatgrass, are well known.

A more recent introduction of Bermuda grass is proving to be a superior hay-producing grass for the South. Permanent pasture management studies have demonstrated the need for further research in developing summer pasture, either by new grazing practices or by the development of drought-, heat-, and disease-resistant pasture plants. Besides studying the herbage values of different grasses and their fuller use in meadows, pastures, and crop rotations for feed and conservation purposes, attention is being paid to methods of inducing and increasing seed production of improved strains. The diseases of grasses are receiving attention and disease resistance is an important element in the breeding program.

(1) FOREST PATHOLOGY

Appropriation Act, 1941.......$245,000
Budget Estimate, 1942......... 245,000

PROJECT STATEMENT

Projects	1940	1941 (Estimated)	1942 (Estimated)
1. Diseases of forest trees and forest products, Investigations of	$131,209	$116,594	$116,594
2. Diseases of shade trees, shrubs, and chestnut orchards, Investigations of..............	50,172	47,156	47,156
3. Epidemic tree diseases, Investigations of..............	81,311	81,250	81,250
Unobligated balance..............	2,700	- -	- -
Total appropriation......	265,392	245,000	245,000

WORK UNDER THIS APPROPRIATION

General. The work under this appropriation is concerned with the evaluation and reduction of losses from diseases in forest, park, and ornamental trees and shrubs and in forest products, in order to decrease the costs and uncertainties of wood production and erosion control, to make wood give better service, and to safeguard aesthetic values. Ordinarily the same fungi attack both forest and ornamental trees and even forest products, and research information on one of the following main projects is frequently of value in the other two, though control methods ordinarily differ.

Project 1. Diseases of Forest Trees and Forest Products;

Objective: To determine the causes, economic importance, and preventive measures for native and naturalized diseases of forest trees and for the defects caused by fungi in forest products.

The Problem and Significance: (a) Publicly operated nurseries have rapidly increased, supplying stock for planting nearly 500,000 acres per year. Approximately 45 tree species are in mass production. A dozen diseases are sufficiently prevalent to increase costs and prevent dependable supplies for the planting programs; some of them are carried on the nursery stock into the plantations.

(b) Native diseases kill trees or materially reduce growth rate of most of our 180 commercial forest species and destroy timber already grown. In connection with the current lumber cut of between 21 and 24 billion feet a year, approximately 3 billion feet is culled for heart rot. In recent years there has been much increase in Government and private funds invested in forest planting and the improvement of existing stands. For financially sound programs for forests, farm wood lots, and erosion-control plantings more information is needed as to probable losses and practicable protective measures.

(c) Research on white pine blister rust is basic for the control program on which as many as 15,000 men were employed during parts of the calendar year 1939. While it has been well established that the best control method is to remove ribes, there are many questions raised by the control organization affecting cost and effectiveness of initial eradication and of subsequent maintenance of protection for the new territory and new species that are being reached by the rust.

(d) The killing of the American chestnut by the Asiatic blight is now nearly complete, and reports of any real comeback of the species have proved unfounded. Over half of the American vegetable tannin has come from chestnut wood and bark but the decay of the killed trees will remove this source. Chestnut tannin is essential for producing heavy leathers (for example, shoe soles), and in time of war there would be no easily available substitute. This tannin supply should be restored. Other products such as poles, ties, lumber, and nuts are also valuable.

(e) The usefulness of wood for all the purposes for which it is employed is probably lessened more by fungous deterioration than by any other single factor. It is estimated that almost 10 percent of the annual timber cut goes for replacements necessitated by decays and discolorations of wood in storage or use. Effective and practicable prevention of fungous defects becomes yearly more necessary and more difficult as it becomes necessary to rely on second-growth timber with its greater proportion of nonresistant sapwood.

Plan and Progress of Work: Pathologists are headquartered in 6 of the Forest Service's 13 experiment station regions and at the Forest Products Laboratory, cooperating closely with State and Federal agencies administering forest land or control programs.

(a) In the western mountain regions, where Federal forest planting was first developed, both the principal parasitic and nonparasitic nursery troubles have been brought down from major to minor importance. As examples of results of studies at some of the newer nurseries, serious damping-off losses and permanent ruining of soil for pine has been avoided by changing acidity of sand used for seedbed cover, and progress has been made in correcting serious malnutritional difficulties.

(b) The attack on native forest diseases is usually indirect, through modification of ordinary management practices. Operations by the Civilian Conservation Corps in the elimination of trees to reduce losses from bark cankers of hardwoods have already been undertaken. Heart rot losses in merchantable stands of some of the more important species have been reduced as a result of studies of external signs of cull and its relation to age and wounds, which makes possible in logging a better selection of trees that can be safely left for a later cut. In the central hardwoods, oaks with high decay hazard can now be recognized while they are young and eliminated in early stand improvement operations; studies toward this end are being extended to the northern hardwoods.

(c) Commercial red currants which apparently do not transmit the white pine blister rust have been found and are being given progeny tests. Preliminary steps are also being taken toward developing resistant strains of eastern white pine. In the West the control forces are helped by distinguishing for them on scores of specimens each year, by a specially developed delicate laboratory method, the pinon pine blister rust. The latter rust also occurs on ribes and cannot be otherwise distinguished from the white pine rust on that host. For the newly invaded regions intensive field studies are made to determine which of the local ribes species need to be eradicated, and to what distance.

(d) Search for blight-resistant American chestnuts and cross breeding with resistant Asiatic chestnut species is being continued. All these trees and their hybrids are being tested in forest plantings and studied for their resistance to blight and other diseases. The Asiatic chestnuts have as much and as good tannin as the American.

(e) Surface fungicidal treatments developed by this Division for the temporary control of sap stain are applied to about 4 billion feet of lumber annually, with a resultant yearly saving of several million dollars. The same fungicides are proving effective in tests on some products other than lumber. The effect on the strength of wood of several of the most prevalent stain and decay fungi has been established as a measure of their seriousness. An efficient labora-

tory method has been developed for evaluating the decay resistance of strains and races of black locust and will be extensively used in determining the fence-post value of strains that are being investigated for erosion-control planting. Decay of buildings has been noticeably reduced as a result of preliminary findings regarding factors favoring their prevalence and methods of prevention. Study is planned toward better evaluation of the importance of various types of building decay and the factors and practices that affect them.

Project 2. Diseases of Shade Trees, Shrubs, and Chestnut Orchards:

Objective: To devise and improve preventive and repair methods for diseases of shade and park trees and thereby reduce heavy losses to individuals and public agencies; to develop chestnuts with desirable horticultural characteristics, combined with resistance to the blight and other diseases, as a basis for the establishment of a chestnut orchard industry in this country.

The Problem and Significance: The large majority of diseases and disease complexes of shade and park trees and the methods of controlling them have been investigated inadequately or not at all. Consequently the losses from diseases are large.

Basic experimental work on the various diseases and hosts is necessary in order to reduce the losses from diseases and the annual expenditures for wound dressings, tree repair, and disease treatment, and the removal and replacement of killed trees. The kinds of shade trees used on a commercial scale run into the hundreds. The number of shade trees has been estimated by some specialists at 250 million and by others at still more. Even at a very conservative average valuation, these represent billions of dollars of wealth. The District of Columbia, for example, estimated that the average 35-year-old street tree has cost $59 for planting and maintenance, and other agencies agree that removing a dead street tree and replacing it with another costs $35. The value of American elms alone, the only species for which a nation-wide census has been attempted, has been estimated at 660 million dollars.

There are over 20 million acres in National parks, which 16 million people visited in 1938, and about 4 million acres in State parks; and the Forest Service has 3,500 camp grounds in the National Forests. The health and good appearance of the trees in these parks and camp grounds must be preserved because they furnish a material part of the attractiveness of these areas.

The developing chestnut orchard industry of the Eastern States was destroyed by blight and root rot, and extensive selection and breeding work will be necessary for its reestablishment on a commercial basis. Chestnut blight is being eradicated wherever found in the Western States. Our recent annual imports of chestnuts from Europe and Asia range from 16 to 22 million pounds.

Plan and Progress of Work: Research and service work on shade-tree diseases are partially on a regional basis but with the principal laboratory located at New Haven, Connecticut. Wound dressings, methods of tree repair, and some of the more urgent disease problems are being investigated in order to decrease the cost of work done by private owners, arborists, and city officials and to make it more efficient. A recent example is the development of an effective control of a rust that made young ornamental hemlocks unsalable. The treatment consists of synchronizing spraying with the time of spore production at an annual cost of only 2 cents a tree.

Research and service work on trees in National, State, and city parks is done by the regional pathologists of the Division of Forest Pathology, who are often called upon to act in an advisory capacity, but the control measures are carried out by employees of the organization concerned. The research work on shade and forest trees is thus directly adapted to the treatment of many trees in the parks. The various parks have very different problems, but the central concept is adjustment of management of heavily used recreational areas so that the natural forest cover will be preserved.

Most strains of the Asiatic chestnuts are resistant to the blight and to root disease. Cooperative orchard plantings of these imported Asiatic chestnuts have been made in 36 States, where they are being evaluated for resistance to blight, root rot, and nut decay, for climatic suitability, and for other qualities. Many plantings are producing abundantly and give promise of an extensive new industry if certain difficulties can be overcome. Over 4,500 hybrid chestnuts have been developed and are being evaluated for orchard purposes. Some hybrids show unusual value as a source of wildlife food and are being tested with public game authorities with a view to replacing the American chestnut whose death was a serious loss to wildlife. Although the blight has been practically eradicated from the Pacific Coast, in cooperation with the State authorities, continued vigilance is planned to prevent reinfection of the plantings, most of which are susceptible species.

Project 3. Epidemic Tree Diseases:

Objective: To investigate as they appear new epidemic tree diseases suspected of foreign origin and unusual capacity for causing loss of our forest and shade trees; to determine the causes of these diseases, their means of distribution, and methods of curing or preventing spread; to allay public alarm in the cases of diseases which appear not to be serious.

The Problem: New diseases are appearing among our forest and shade trees which behave in such a way as to indicate that they will spread in epidemic form and do great harm to our trees. Some are introduced from foreign sources; others appear suddenly without clue as to their origin. Some prove to be of little danger, in which event the investigations are closed; others prove of major importance and require

prompt effort to gain necessary information and find any possible methods of preventing or delaying their spread before they get too far. Asia especially contains many close relatives of important American timber species, from which additional dangerous parasites can be expected to come. The most important recently introduced disease at the present time is the Dutch elm disease. The problem is much complicated by a virus-caused phloem necrosis disease in the Ohio River valley where the Dutch elm disease is present, and its carrier beetle is rapidly spreading. Congress has pr scribed that this disease shall be included in the Dutch elm disease control program. Its method of transmission is unknown.

Significance: The 660 million dollar estimate of American elm value has been referred to under the preceding project. The Dutch elm disease is the subject of a control program conducted by the Bureau of Entomology and Plant Quarantine costing this year more than 1 1/2 million dollars.

A single tree species, Douglas fir, supplies nearly one-third of our saw timber. Ponderosa pine is the only commercial species on great areas. A disease destroying the commercial value of either of these, or of any of a number of other major forest or shade trees, as completely as the blight did the chestnut or even to a somewhat lesser degree, would be a national calamity. The destruction of additional minor species (we appear now to be losing the mimosa and the persimmon) would be a decided misfortune due to the loss of aesthetic or soil improvement values.

Plan and Progress of Work: Work is concentrated on the currently most important disease as follows:

(a) Dutch elm disease: That the fungus Ceratostomella ulmi is the cause of the Dutch elm disease, that it is chiefly carried from tree to tree by scolytus beetles and also by natural root grafts, and that it is introduced into the tree in feeding scars and fruits on exposed wood and in insect tunnels have already been determined. Methods of scouting for and identifying the disease have been devised. Preliminary tests of the curative values of about 100 chemicals have been made. Research on the elm problem is now concentrated on 5 topics: (1) Hunting for American elms resistant both to the Dutch elm disease and the phloem necrosis, and breeding American and other elms to secure resistant elms; (2) search for preventive or curative methods of injecting, feeding, or otherwise treating living valuable elms; (3) studies of the development of the disease in the individual tree to furnish a better foundation for control work; (4) study of the insect relations of the fungus to assist the control program; and (5) study of the method of transmission of phloem necrosis from tree to tree and of its spread in the tree to secure a basis for the prescribed control program.

(b) Little leaf of the shortleaf pine: Research on this important new disease in the South is aimed at (1) discovery of the

cause of the disease, (2) nature of the symptoms and amount of damage, and (3) relation of soil types, soil conditions, and climate to the disease.

Adelopus needle cast of Douglas fir: Study of the identity of the fungus in the serious killing epidemic in Europe, the killing and defoliation in New England and New Mexico, and the apparently harmless condition on the Pacific slope, thus to evaluate the significance of this disease and to determine its threat to our most valuable timber tree.

Fir needle cast: Evaluation of the importance of an outbreak of this disease on balsam fir in Maine and possible relation to a similar harmful disease in Europe.

(c) Planetree or sycamore disease: This disease has also been shown to be due to a Ceratostomella and is carried on tree pruners' tools such as saws, ropes, knives, and axes, and in wound dressings. Current research aims to discover (1) other means of spread, (2) means of disinfecting wound dressings, (3) resistant trees which can replace lost ones, (4) other means of combating the disease, and (5) methods of local control.

Persimmon wilt: Attacked by a wilt-producing Cephalosporium which is wind distributed, the American persimmon as a whole is doomed. Present work is confined primarily to search for and production by breeding of resistant trees and secondarily, to the determination of the source of the disease and how it is entering the country.

Work on the Phomopsis canker and the Northwest canker of Douglas fir, the Atropellis canker of slash pine, the Monterey cypress canker, the mimosa wilt, Nectria canker of beech, willow scab, and larch canker has been practically completed or is being limited to observation of developments.

(m) FRUIT AND VEGETABLE CROPS AND DISEASES

Appropriation Act, 1941	$1,300,000
Transferred in 1942 estimates from:	
"Botany" (wild plant improvement - blueberries, gooseberries, etc.)	5,000
"Experimental Greenhouse Maintenance" (all)	77,372
"Soil-Fertility Investigations" (citrus, pecan, and potato soil-fertility investigations, and soil-fertility investigations on truck and miscellaneous crops - strawberries)	43,990
Total available, 1941	1,426,362
Budget Estimate, 1942	1,426,362

PROJECT STATEMENT

Projects	1940	1941 (Estimated)	1942 (Estimated)
1. Deciduous fruit investigations	$306,700	$294,898	$294,898
2. Citrus, avocado, and other subtropical fruit investigations	117,514	113,303	113,303
3. Nut investigations	258,916	246,824	246,824
4. Vegetable investigations ...	287,212	285,734	285,734
5. Floricultural and ornamental horticultural plant investigations	71,865	68,896	68,896
6. Nursery stock and farm windbreak investigations	66,815	65,955	65,955
7. Potato investigations	100,536	99,228	99,228
8. Methods of handling, transportation and storage, and market diseases of fruits, vegetables, and flowers, Investigations of	184,231	174,152	174,152
9. Experimental greenhouse maintenance	77,195	77,372	77,372
Unobligated balance	4,360	- -	- -
Total appropriation	1,475,344*	1,426,362*	1,426,362

* Includes $126,362 for work proposed for transfer in the 1942 estimates.

WORK UNDER THIS APPROPRIATION

General. The work under this appropriation relates to the production, improvement, handling, storage, and transportation of horticultural crops and crop plants, including fruits, vegetables, nuts, and ornamental plants such as flowers, florists' stocks, shrubs, and trees, as well as plant materials suitable for farm windbreaks. The work includes investigations on cultural methods, breeding and selection, regional adaptability, propagation, diseases, and methods of handling, transportation, and storage, with a view to improving quality and marketability and to lowering production costs per unit of product. The farm value of leading fruit and vegetable crops during the 5 years from 1934 to 1938 has ranged from $769,424,000 to $1,210,219,000 per year. The carlot shipments (not including amount moved by motor truck) during the same period have ranged from 691,597 to 877,774 carloads of perishable products per year.

Field stations, laboratories, and offices where work is conducted are located at the following points:

Field Stations (Government-owned land or held under long lease)

California, Fresno
" Indio
" La Jolla (Torrey Pines) (long lease)
" Oakville
Florida, Orlando (long lease)
Georgia, Fort Valley (long lease)
Georgia, Tifton (long lease)
Louisiana, Robson
Maryland, Beltsville
Mississippi, Meridian
South Carolina, Charleston
Texas, Brownwood (long lease)
Wyoming, Cheyenne

Field Stations (land furnished)

California, Palo Alto
Colorado, Greeley
Georgia, Philema
Maine, Presque Isle
North Carolina, Willard
Oregon, Medford

Field Office

California, Sacramento

Field Laboratories

Arkansas, Fayetteville
California, Los Angeles
" Pomona
" Riverside
Florida, Gainesville
" Orlando
Georgia, Albany
" Cairo
Illinois, Chicago
Indiana, Lafayette
" Vincennes
Louisiana, Bogalusa
" Shreveport
Massachusetts, East Wareham
Missouri, Columbia
New Jersey, New Brunswick
New Jersey, Pemberton
New York, New York
Oregon, Corvallis
" Hood River
Utah, Logan
Washington, Wenatchee
" Yakima
Wisconsin, Madison

Project 1. Deciduous Fruit Investigations:

Objective: To develop better-quality, more disease-resistant, better-adapted varieties of deciduous fruits, and to determine conditions necessary for their growth, the best management practices for their successful production, and the cause and methods of control of diseases to which they are subject.

The Problem: The problem divides itself into three main sections: (1) the study of present varieties, including their adaptation and weaknesses, and, through systematic breeding, the development of new varieties superior to those now in existence; (2) investigations on cultural requirements to determine the best production practices; and (3) investigations on the nature and causes of the diseases affecting these plants and development of the best disease-control practices.

The development of new varieties. Most of the varieties of fruit now used have developed as chance seedlings which have been selected and propagated to become commercial varieties. Practically all of them have certain weaknesses, such as poor quality, lack of sufficient hardiness, disease susceptibility, and others. The development of superior varieties affords perhaps the greatest opportunity for permanent improvement in our fruit industry. Such development is possible only through systematic and long-continued fruit breeding work.

Extensive programs of fruit breeding are under way, particularly with apples, pears, peaches, grapes, strawberries, blackberries, raspberries, cranberries, and blueberries. In general, the breeding program is built around improved disease resistance, greater hardiness, and improved fruit quality.

Cultural requirements. These investigations include studies of soil adaptation, fertilization, irrigation, pruning, fruit thinning, and other factors concerned in the management of fruit plantings. Fundamental studies are conducted to determine the relations of fruit plants to nutrient materials, water supply, climatic and environmental conditions, etc. These investigations furnish the basis of practical recommendations relative to the growing of these fruits in various parts of the United States. They are aimed primarily at determining practices which will result in a regular production of good-quality fruits.

Cause and control of orchard diseases. There is too little information on the nature and causes of the various plant diseases, the life histories of the organisms causing them, the development of improved spray materials for protection against the different diseases, and investigations on the effect of materials and times of application on disease control. Breeding to secure more disease-resistant varieties is also an integral part of this problem. Even with the best disease-control methods now available, extremely heavy losses to these crops continue to occur. Without the disease-control methods that have been developed during the past 50 years, production of many of these crops would be impossible at present. New diseases and new forms of old diseases continually develop, and the fight against plant diseases must be pressed continually.

Significance: Very great investments are represented by the fruits covered by this project. The land involved comprises an estimated four to five million acres. The value of the land is but a fraction of the investment, since the trees must be planted and cared for from three to ten years before a paying crop can be expected. Orchard implements and packing houses with their equipment must be provided. Furthermore, the annual investment in producing, harvesting, and packing the crop, before any seasonal returns are received, may be as much as 75 cents per bushel, or even more in some cases, for apples. This does not include merchandizing and shipping costs.

Apple production during the past decade has varied from about 117,000,000 to more than 210,000,000 bushels annually, with farm values varying in different years from less than $112,000,000 to nearly $160,000,000, depending on the size of the crop and prices received. The peach crop has varied in recent years from about 45,000,000 to nearly 60,000,000 bushels, the farm value of which ranged from approximately $33,000,000 to well over $60,000,000 annually. The pear crop averages around 25,300,000 bushels, valued at the farm at about $16,000,000, with a high annual value of more than $21,000,000. The grape crop, year by year, has an average annual value on the farm of some $41,400,000. The value to the growers of the strawberry crop has varied in the past few years from a low of less than $20,000,000 to a maximum of $34,400,000. The other fruits in the group named above represent smaller values, but the aggregate adds many millions of dollars to the total, which may aggregate as much as $325,000,000. Stabilization of crops, through research for development of improved varieties and control of response to conditions is of major importance in an industry of this extent.

Enormous losses are suffered annually from fruit diseases. The best available estimates for some of these losses, based on averages for the years 1934-38, inclusive, are: for apples, 15,000,000 bushels, or 10 percent of the crop; pears, 1,500,000 bushels, about 6 percent of the crop; peaches, 10 percent, or 5,100,000 bushels; strawberries, nearly 14 percent, or about 1,600,000 crates; grapes east of the Rocky Mountains, about 11 percent of the crop. These losses occur even with the expenditure of many millions of dollars annually by fruit growers in the application of control measures.

Plan and Progress of Work: Deciduous fruit investigations are grouped under ten work projects, each of which is subdivided into a number of research line projects. Much of the work is done at the U. S. Horticultural Station at Beltsville, Maryland, but phases of it are carried on at 23 field stations and laboratories in 16 States representing important fruit-production centers in various sections of the country, and in many cases in cooperation with State experiment stations and private individuals. This is for the purpose of broadening the tests and obtaining information regarding the influences of different climatic and other environmental factors on plant responses. Special phases of breeding and adaptation research are carried on at the Cheyenne (Wyoming) Horticultural Field Laboratory.

In the breeding work collections of breeding stock have been assembled, including a wide range of varieties from various parts of the world. Crosses are made to secure combinations of desirable qualities. Large numbers of progenies are grown to fruiting, and the most promising are propagated and tested more extensively under a wide range of conditions. Varieties that show definite superiority in any region are named and introduced through regular nursery channels. Outstanding results have already been achieved in securing improved varieties of peaches, strawberries, blackberries, and particularly blueberries, and greatly improved varieties of other fruits are in prospect. The amount of material under test is such that new intorductions of one or another sort of deciduous fruit are to be expected annually.

Investigations on cultural requirements have yielded information of great value in regulating the applications of fertilizers to best meet the needs of the plants. Information is being developed that makes possible overcoming to a considerable extent the biennial-bearing habit of fruit trees under certain conditions and of delayed leafing due to mild winter weather in southern regions. A promising method is being developed to prevent premature dropping of fruit of certain apple varieties. Problems connected with fruit growing under irrigation are yielding valuable information.

Definite progress is being made in improving present methods of controlling a wide variety of fruit diseases, developing new methods of control, investigating new virus, fungous, and bacterial diseases of fruits, and determining the most practical methods for combating them. Definite progress is being made in breeding varieties for disease resistance or immunity.

Project 2. Citrus, Avocado, and Other Subtropical Fruit Investigations:

Objective: (1) To develop effective production methods and practices necessary to reduce operating costs to the grower and provide the consumer with more satisfactory fruits of superior quality; (2) to develop through breeding and selection improved varieties of citrus and other subtropical fruits; (3) to devise methods for effective disease control.

The Problem: In spite of the great increase in production of citrus fruits in recent years, much of this fruit has given little or no profit to growers. All indications point to even larger crops in the years immediately ahead. If the country is to continue enjoying an abundance of these fruits, the growers must net enough to keep them in business. One of the most promising approaches to this problem is to reduce costs of production through research.

The problem involves cultural methods and procedure and development of varieties that are superior in eating, shipping, and storage quality, are more productive of higher grade fruit, are borne more regularly, and are resistant to cold and diseases. The cultural aspects of the problem concern such matters as tillage practices, maintenance of soil fertility (including the use of fertilizers and cover or soil improvement crops), irrigation, pruning, and all other features of orchard management that affect the

ultimate end -- the crop produced with the maximum degree of profit commensurate with costs of production. Regional adaptability of varieties and suitability of rootstocks are important factors.

Heavy losses are suffered every year because of destructive diseases either to the fruit or to the tree or plant. The control of disease is based on a knowledge of life history and the application of an effective fungicide at the proper time or times, or the use of other measures to prevent their occurrence. This problem frequently reduces to one of breeding fully acceptable varieties that are adequately resistant to disease.

Significance: The extent of production and present status of some of the more important subtropical fruits are outlined in the statements that follow:

Oranges. As of July 1, 1939, it was estimated on the basis of previous surveys that there were in the United States 36,538,000 orange trees 5 years old and older. Of this number 7,423,000 were between 5 and 10 years old, 7,453,000 between 11 and 15 years old, and the remainder 16 years and older. The 5 to 10 and 11 to 15 year groups include about 40 percent of the trees in bearing. This fact portends a material increase in orange production during the next several years, assuming favorable conditions, since trees under 15 years of age have not reached the stage of full production.

Grapefruit. A like survey of grapefruit trees in the United States indicated a total number in bearing of 13,232,000, of which 4,778,000 were in the 5 to 10 year group and 3,777,000 in the 11 to 15 year group; that is, about 65 percent of the trees had not reached full bearing age in 1939. This situation obviously indicates a heavy uptrend in production.

Lemons. Commercial lemon growing is substantially restricted to California, only a few thousand boxes being produced annually in other States. As of July 1, 1939, there were an estimated 5,792,000 lemon trees in that State, excluding any plantings made in 1939. Nearly 45 percent of the total number were in the 1 to 10 year group, while more than half the trees were under 16 years of age.

Limes. The commercial lime crop in this country is practically all produced in Florida. Production which reached low ebb in 1927 and 1928 increased slowly until about 1935, but has increased very materially since the latter year. In 1938 the estimated crop was 95,000 boxes, which was 25,000 boxes more than the crop of the previous year. The estimated farm value of the crop for 1938 was $200,000.

The most conspicuous feature of the above comments regarding citrus fruits is the indication of a prospect for an upward trend in production during the next 5 or 10 year period. The great volume of production presents serious economic problems, of which reducing costs of production and handling must come in for every possible consideration.

Avocados. This fruit is grown in Florida and California. The average production in California for the years 1928 to 1937 was 3,616 tons; in 1938 - it was 14,100 tons. In Florida the 10-year average was 1,240 tons; for 1938 it was 2,220 tons. In California figures for 1938 gave 12,532 acres in bearing avocado trees and 1,653 acres in trees not of bearing age, the latter carrying a total of about 1,200,000 trees. In Florida it was estimated in 1938 that more than 3,000 acres were planted to about 210,000 trees.

Figs. Important commercial production exists in California only, although a small industry occurs in the Gulf Coast region of Texas and a few thousand cases are canned or otherwise preserved in Louisiana, mostly of fruit assembled in small lots. While widely distributed in other parts of the Coastal Plain area, this fruit is not produced in those areas in commercial quantities but is important for local use. In California the estimated area in 1938 devoted to fig trees in bearing was about 38,000 acres, with an estimated production equivalent to more than 34,800 tons, dry weight.

Olives. Olive production in the United States is nearly an exclusive California industry, with only very small interests in Arizona. In 1938 it was estimated that about 24,675 acres were devoted to this fruit, nearly all of which was in bearing. Yield varies greatly. In 1938 it was 44,000 tons, only half that estimated for 1939.

Dates. Dates are produced mainly in California, with small interests in Arizona. It was estimated in 1938 that about 3,280 acres were in dates in California, all but 760 acres of which were in bearing. Yields during the 5-year period 1934 to 1938 have varied from about 2,600 to 3,970 short tons, but within this period they have not been below 3,230 tons since 1935.

While other subtropical fruits are of some local interest, they do not constitute commercial industries of any considerable importance and very little data are available regarding them.

Plan and Progress of Work: In the Southeastern States the work centers at Orlando, Florida, at the United States Subtropical Fruit Field Station; in the Southwest, at the United States Date Garden at Indio, California. However, research work is in progress at numerous places in the States concerned in cooperation with State agricultural experiment stations and private individuals.

Unusually comprehensive collections of stock materials of citrus fruits of all types, avocados, mangoes, and papayas are maintained for the breeding program. Emphasis is placed on securing resistance to prevalent diseases and to cold. A considerable number of desirable varieties have been developed and introduced, and much promising material is undergoing critical testing. Selection of buds from trees of superior merit has done much to improve the quality of nursery trees and their later performance in the orchard. Distinctly superior strains have been introduced to the trade and others are in process of testing.

Improvements are being made in methods for combating the various diseases of this group of fruit crops. The responses to nutrients, to irrigation, and to cultural practices are being studied in extensive investigations planned for a series of years.

Various practical problems in culture and adaptation are being investigated in connection with the establishment of date culture in certain areas in California and Arizona.

Project 3. Nut Investigations:

Objective: (1) To determine the soil, climatic, and cultural requirements of the various nuts grown commercially in the United States; (2) to breed better and more suitable varieties of each; (3) to develop control measures for diseases that affect nuts grown commercially.

The Problem: The bringing under cultivation of a wild species, such as the pecan, under soil conditions differing greatly from those of the native habitat, has brought many problems. Among them are: Adaptability of varieties to soil and climate; cultural requirements to induce early and sustained bearing; spacing of trees and systems of pruning for greatest per-acre production; intercropping systems to secure greatest returns per acre from pecan orchards; control of diseases that reduce the merchantable crop and prevent fruit-bud formation for the following year; breeding of superior varieties of high productiveness, hardiness, and disease resistance, with nuts of better shelling quality, flavor, and kernel texture.

The problems in Persian (English) walnut production include: Overcoming unfruitfulness due to the maturing of pistillate and staminate flowers at different times; delayed foliation; walnut blight and root decay; obscure causes of unproductivity and decadence in orchards; determination of cultural, fertilizer, and irrigation requirements; influence of soil aeration on tree growth; varietal adaptations.

Problems in the comparatively new filbert and almond industries include: Development of superior varieties; overcoming orchard unproductiveness; prevention of disease losses; determination of the causes of orchard decline; and the soil, cultural, irrigation, and fertilizer requirements of the trees.

In tung-nut production, hardier types are needed which are productive and have high oil content. The industry is new, and investigations are necessary on all phases of propagation, culture, systems of orchard management, disease control, and selection and breeding of superior types.

With but few exceptions, the varieties now being grown of each of these important nut crops originated either as chance seedlings or were introduced from some foreign country and do not possess all of the qualities desired for most successful production in the United States.

Difficulties in rapid and economical vegetative propagation of chestnut and tung must be overcome to permit extensive use of new disease-resistant and otherwise superior types that are being developed by selection and breeding.

There is definite need for the development of satisfactory types of nuts for growing in the Northeastern United States, where native hickories, walnuts, and chestnuts do not fully meet requirements.

Significance: The number of kinds of nuts planted and grown commercially in the United States is small, comprising the pecan in the Southeastern States and certain adjacent areas; the Persian (English) walnut, restricted practically to the Pacific Coast States; the almond in California, filbert in the Pacific Northwest, and several others.

Of native nuts such as the black walnut, several hickories, the hazel, and chestnut, there are a number of horticultural varieties, but the most of the plantings consist of only a few trees each. However, large quantities of kernels, especially of black walnut and to a much lesser extent of hickories, are marketed every year from trees growing in the wild. In some sections the returns from such nuts add substantially to the cash income of those who harvest them. As a rule they are people of low income at the best. The introduced Asiatic chestnuts are replacing the native American chestnut, which was destroyed by the chestnut blight disease, and are now being grown in increasing quantities in the Northeastern and Southeastern States.

In recent years there has been an increasing use of nuts in the diet. The extent of their use for edible purposes in one form or another is indicated in the following data:

Kind of Nut	U. S. Production Range in 1934-38	Farm Value Range in 1934-38
Almonds	15,200,000 lbs. to 40,000,000 lbs.	$1,960,000 to $5,500,000
Filberts	2,000,000 " " 4,460,000 "	200,000 " 500,000
Pecans	40,135,000 " " 105,975,000 "	4,247,000 " 6,716,000
Walnuts (Persian)	86,600,000 " " 120,200,000 "	8,741,000 " 11,240,000

Kind of Nut	Imports Range 1933-34 to 1937-38
Almonds - shelled	2,986,000 lbs. to 11,270,000 lbs.
" not shelled	2,000 " " 2,731,000 "
Brazil nuts - shelled	6,525,000 " " 10,149,000 "
" " not shelled	12,697,000 " " 23,385,000 "
Cashew nuts	14,069,000 " " 26,117,000 "
Chestnuts	12,680,000 " " 22,213,000 "
Filberts - shelled	1,960,000 " " 2,425,000 "
" not shelled	206,000 " " 4,213,000 "
Pistachio nuts	1,559,000 " " 3,538,000 "
Walnuts (Persian) - shelled	4,160,000 " " 5,632,000 "
" " not shelled	30,000 " " 321,000 "

Tung nuts are grown as a source of oil used in paints and varnishes. While first introduced from Chi about 1905, it is only within the past 10 or 15 years that this crop has attracted widespread attention leading to extensive research in its production in this country. So far as now known, the growing of this nut in the United States is likely to be restricted to the Gulf Coast region of the Southern States within perhaps a hundred miles or so of the Coast.

It is estimated that something like 120,000 acres of land have been planted to tung trees in the South, mostly during the past 10 or 12 years; very few trees are in full bearing. In 1936 approximately 2,000,000 pounds of oil were produced. In 1937 the crop was nearly all destroyed by low temperatures in late spring. The 1938 yield of oil was originally estimated at 4,000,000 to 5,000,000 pounds, but a drought during the summer reduced the actual yield to 3,000,000 to 3,500,000 pounds. The crop was again cut very heavily in 1939 by low temperatures at critical times. The commercial supply of tung oil used in industry in this country is practically all imported from China, or has been in the past. Annual importations have reached 175,000,000 pounds. The significance of our tung investigations is expressible in terms of a new commercial industry for a considerable portion of the Coastal Plain region of the Southern States. The possibility of developing a profitable tung-oil industry in this region remains to be demonstrated.

Plan and Progress of Work: The research activities under the project "Nut Investigations" are centered for the most part at 14 field stations and laboratories in 10 States in the regions where the various nuts are grown. The headquarters of the Nut Investigations project is at the U. S. Horticultural Station at Beltsville, Maryland, where much of the work on northern nuts is conducted. Some of the work is in cooperation with State experiment stations with staff members headquartered at these stations, or test plantings are made on land furnished by the stations. There is also extensive cooperation with growers in whose orchards research is conducted.

Breeding stocks of the edible nut types have been assembled from all available sources, a large amount of hybridization has been done over a period of years, and new progenies for testing are being grown each year. A number of promising new varieties are undergoing regional testing for their horticultural value. Crosses between distinct species are yielding important new types in the case of native hardy nuts. Tests are being made of the horticultural value of blight-resistant chestnut hybrids developed by the Division of Forest Pathology.

The research work on the pecan has reached the point where systems of orchard culture are resulting in satisfactory yields on a profitable basis in representative localities. These include mainly soil improvement, disease and insect pest control, correction of nutritional deficiencies, reduction of stand when necessary, and suitable intercropping. Each of these factors and their interrelations offer special problems, and much still remains to be accomplished.

Special pollination problems of Persian (English) walnuts have been met by development of emergency methods of hand pollination which can be

done at small cost. Further research is necessary on varieties that should be interplanted or topworked in different sections and under different conditions to best insure adequate pollination on a permanent basis. Breeding, selection, and trial of new introductions are under way to secure varieties having less prolonged winter dormancy than those now in culture. Effective spray programs for bacterial blight control have been worked out, and efforts are now directed to overcoming the sometimes injurious effects of the sprays. More economical ways of supplying the zinc and boron requirements of the trees are being investigated.

Notable is the introduction this year of two varieties of almond, one the equal in quality of those most grown in this country and otherwise better adapted to our conditions; the other, distinctly superior in quality to the high-grade imported almonds. This second variety promises to make possible successful competition for the fancy almond trade by domestic producers. Definite progress is being made in solution of problems relating to varieties, soils and maintenance of their fertility, fertilizers, cultural requirements, regional adaptation, and disease control.

The recently initiated research program on tung culture includes investigations on soil and nutritional requirements; cultural methods; disease control; selection of types superior in cold resistance, productiveness, and oil content; crossing types to secure desired combinations of qualities; methods of propagation; maturity and storage of nuts.

Project 4. Vegetable Investigations:

Objective: (1) To develop varieties of vegetables better adapted to consumer needs and more resistant to diseases and other environmental factors; (2) to eliminate or control factors that limit or restrict the successful production of vegetables; (3) to determine cultural practices most suitable for economical vegetable production.

The Problem: Exacting requirement of markets, processors, and ultimate consumers for special culinary and market qualities in vegetables necessitates development through selection and breeding of varieties possessing such qualities. The growing of vegetables in special areas at long distances from center of consumption and to supply the markets at various times of the year demands cultural, adaptation, and improvement investigations of complex character. Fundamentally important is work on standardization of varietal types to insure uniformity and high quality of the strains produced by seedsmen and on methods of seed handling and storage to preserve high vitality as a means of lowering seed costs and insuring good stands of crops.

Fungous, bacterial, and virus diseases exact a tremendously high toll from vegetable crops. Improvements must be made in effectiveness and economy of methods for controlling long-established diseases. Each season some new disease appears, or an old disease develops in a new locality in such way as to require emergency efforts for control, and extensive investigations are required on the casual agent, methods of spread and infection, and other essential facts.

In certain sections of the South many millions of tomato, cabbage, and other plants are started in the open ground and shipped to northern growers for planting in the field. Certain diseases developing in the seedling stage or in transit result in heavy losses through failure of the plants when set in the field to develop and fruit satisfactorily. The determination of the diseases, means of infection, and methods of control constitutes a problem that is vital.

The need for improved sweetpotato varieties, including those having high starch content suitable for use in starch manufacture, has necessitated an extensive program of sweetpotato breeding and testing.

This enumeration, noting as it does only a few items, merely suggests the scope and diversity of the research work that is needed for producing high-quality vegetables at low costs.

Significance: For the 10-year period 1928 to 1937 an annual average of 2,711,420 acres was devoted to leading truck crops for market and for processing. The total for 1938 was 3,121,510 acres; for 1939 it was 2,851,640. These figures do not include potatoes and sweetpotatoes.

Losses from diseases of truck crops vary widely for different crops and localities and seasons. The following figures give the estimated percentage and volume of reduction over the whole country of a few crops for a period of 3 to 6 years up to 1936:

	Average percent 1931-36	Average volume reduction
Sweetpotatoes	9.3	4,420,000 bu.
Tomatoes (for manufacture)	12.5	145,300 tons
Tomatoes (for market)	16.2	2,280,000 bu.
	Average percent 1934-36	
Snap beans (for manufacture)	5.4	2,720 tons
Snap beans (for market)	16.9	1,860,000 bu.
Green peas (for manufacture)	5.7	9,240 tons
Green peas (for market)	8.7	330,000 bu.

Present-day dietary advances and standards give emphasis to the importance of adequate supplies of fresh or properly preserved vegetables in the national economy. The investigations under this project are fundamental to supplying the raw material to meet this need in greatest measure and most economically.

Plan and Progress of Work: The work centers in the greenhouses, laboratories, and fields at the U. S. Horticultural Station at Beltsville, Maryland, at 15 field stations and laboratories in 12 States, in various vegetable producing centers, at the Cheyenne (Wyoming) Horticultural Field Station, and in cooperation with State experiment stations and individuals.

Extensive breeding investigations are in progress for the progress for the development of improved varieties better adapted to diverse conditions of growth, better suited to particular purposes, and resistant to disease. Breeding stock has been assembled from various parts of the world. Many new varieties have been introduced.

Some of the accomplishments of research have been (1) the virtual saving of the lettuce industry of southern California (farm value $5,000,000 annually) and adjacent areas through the breeding of varieties resistant to certain destructive diseases; (2) similar results being experienced in the cantaloupe industry of the Imperial Valley from which 5,380,000 crates, worth about $7,000,000, were shipped in 1937, the product of 29,890 acres of land, practically all of which was planted to a disease-resistant variety developed in our breeding work; (3) the development of tomato varieties resistant to certain destructive diseases, which has made possible the profitable continuing of tomato growing in certain areas, especially the Middle Atlantic and Southeastern States; (4) the development of cabbage varieties resistant to "cabbage yellows", which have saved many thousands of dollars to the industry; (5) the production of superior varieties of snap beans, lima beans, and lettuce for the East, as well as for the Southwest, and other introductions as a result of vegetable breeding work; and (6) discovery from studies of a serious virus disease of celery in Florida that the insect carrier lived over winter in certain infected weeds commonly found growing in areas adjacent to the celery field.(the simple expedient of freeing the areas of these weeds practically eliminating the celery disease); and (7) the development by selection of high-yielding strains of both Spanish and fancy large-seeded Virginia peanuts, which has made possible greatly increased per-acre yields of this crop(1,650,000 acres or more planted annually at a crop worth more than $30,000,000 on the farm). The large-seeded forms also bring a premium for their large size.

Project 5. Floricultural and Ornamental Horticultural Plant Investigations:

Objective: (1) To determine the requirements for successful production of flowering bulbs in suitable sections in the United States; (2) to develop through breeding and selection improved varieties of flowering plants useful as florists' stocks and for home growing; (3) to devise means for the control of diseases of floricultural and ornamental horticultural plants, and for overcoming hazards and hindrances in the cultivation of such plants for home beautification or as a business.

The Problem: Large quantities of bulbs have been imported annually from Europe, Bermuda, and Japan. Soil and climatic conditions in certain regions in this country are suitable for production of many classes of these bulbs, but a large amount of investigational work is necessary to adapt cultural methods to new situations, to test the suitability of varieties for profitable production, and to breed new varieties better adapted to our conditions or superior in other ways.

The forcing of flowering plants for the florists' trade depends on careful control of a number of conditions. More exact knowledge of plant responses to various environmental factors or other stimuli would lead in

many instances to more profitable production by producing flowers either of better quality or at times when they are in better demand.

Recent developments in breeding can be used to advantage by practical growers of seed stocks to keep their strains true to type and of highest quality to meet demands of florists and flower lovers.

Vast improvement in varieties of all kinds of flowering and ornamental plants is possible through the use of modern breeding technique.

Plant diseases of a wide range of types prove destructive alike to the crops of the professional growers and in the home gardens of the general public. Exhaustive study of diseases of flowering and ornamental plants has lagged behind investigations on diseases of farm and orchard crops, despite the relatively high intrinsic and esthetic worth of the former.

Significance: The investigations under this project pertain to ornamental plants, including florists' stocks, in both greenhouse and outdoor culture, flowering bulbs, and other annual and herbaceous plant materials; also shrubs for home ground and public planting, trees for shade, street, and park plantings, and plants for other decorative purposes.

There are no adequate data on the extent of the ornamental plant industry. In 1929 there were imported some 235,000,000 or more bulbs, including hyacinths, tulips, daffodils, and others, valued at nearly $7,000,000. In 1932 the importations of the same items amounted to from 140,000,000 to 150,000,000 bulbs. In 1935 the number was less than 130,000,000. This probably does not signify the use of a reduced number of bulbs, but rather that domestic production supplied an increasingly large proportion of the demand. According to the 1930 census, the nursery sales of ornamental trees, shrubs, and other similar plants, not including annuals, herbaceous plants, or bulbs, amounted to about 110,000,000 specimens, and on April 1, 1930, there were about 340,000,000 specimens of the same items of all ages growing in the nurseries for future sale. The results of a survey made by the floricultural industry in 1939 revealed that in 1938 the wholesale value (amount paid to growers) of cut flowers produced under glass was $120,000,000; and in the same year 76,000 acres of land were devoted to the growing of flowers in the open for the cut-flower trade, the wholesale price of which was $98,000,000, or a total wholesale value of cut flowers in 1938 of $218,000,000. The retail value was of course a vastly larger sum. Added to this is the immense volume of floral and ornamental plant material grown by the home owner for his own satisfaction.

Plan and Progress of Work: The investigations center in the laboratories, greenhouses, and field at the U. S. Horticultural Station at Beltsville, Maryland, and certain phases are conducted in cooperation with various State esperiment stations and with private growers, in five States, as well as at the Cheyenne (Wyoming) Horticultural Field Station.

The work includes cultural studies; breeding for the development of better varieties, including disease resistance; investigation of diseases

and their control; storing and handling of the various planting stocks, especially for forcing purposes, and particularly the effects of storage treatments on time of flowering and quality of the flowers. The cultural work with bulbs has developed information needed for their successful production for the trade under American conditions to replace the supplies of many of the more popular bulbs largely imported from Europe and other countries. Particular attention in this connection has been given to narcissus, tulips, and various lilies, including Easter lilies, and there has been considerable development of production of these bulbs in several regions. The usual sources of many of the bulbs are now cut off by prevailing war conditions.

Particular attention is being given to diseases of flowering bulbs, roses, azaleas, boxwood, florists' stocks, and many other ornamental plants, and new or improved methods of control have been devised.

Investigations have shown that by proper regulation of storage conditions for the bulbs, especially temperature, the time of blossoming of certain flowering bulbs can be closely regulated, thus making the blooms available for market when they will command the best prices. Tests are made of the storage-keeping quality of varieties of florists' stocks under various conditions.

Large stocks of plants have been assembled for breeding work, and notable progress has been made with Easter lilies and other lily types, with narcissus, columbine, rose, tulip, carnation, chrysanthemum, and others. A number of superior varieties have been developed and have been introduced or are undergoing further testing with that in view. Among the newer developments are types of Easter lilies far superior to the present ones. Studies are conducted to develop knowledge that will be of use to practical seed growers in the production and maintenance of superior strains to be placed in the trade. Rapid and dependable methods of propagation have been devised to build up stocks of desirable selections.

The effects of growth-stimulating chemicals are being studied with a view to determining possible usefulness in floriculture or in the development of new genetic types.

Project 6. Nursery Stock and Farm Windbreak Investigations:

Objective: (1) To develop better nursery stock, economically produced, properly grown and handled, free from and resistant to diseases, some of which now cause serious losses; also vigorous and long-lived understocks, hardy and congenial, with the top budded or grafted thereon, and adequately adapted to soil conditions where grown; (2) to determine the effectiveness of the farm windbreak, especially in the Central Great Plains area, what plant material to use, and how to propagate and develop it.

The Problem: The nursery industry is basic to the fruit industry, to many aspects of ornamental horticulture, and to tree and shrub planting in general. The methods and practices used by the industry have developed largely by empirical methods. Many of our present practices go back to

old rule-of-thumb experience of long ago. This does not mean that they necessarily should be superseded by other methods, but, since ultimate results are faulty in many respects, it does mean that research for improvement is needed.

Many of the understocks used in propagating fruit trees and other plants lack resistance to cold, are susceptible to disease, sensitive to soil conditions, are not congenial with the varieties budded or grafted on them, or in some other respect are a limiting factor in the behavior of the tree or other plant propagated on them. The finding or the development of understocks that would overcome these weaknesses would greatly enhance the long-time value and performance of orchard or other plants grown on such an understock.

Improper storage conditions for nursery stock each year result in losses of many thousands of dollars due to holding the stock under conditions that cause or fail to prevent weakening in vitality or other forms of deterioration. Diseases likewise cause large losses in nursery stock in both field and storage.

The best selection and proper arrangement of trees for farm windbreak planting in the Great Plains area should result in better conservation of soil moisture through lessening the effects of drying winds; in the better distribution of soil moisture by preventing the drifting of snow in the winter; in preventing the distortion of fruit trees and other vegetation by breaking the force of strongly prevailing winds; in preventing wind erosion of the soil; and, in general, in creating more pleasant surroundings in which to live and develop a more profitable agriculture.

Significance: Broadly, this project deals with the propagation of trees, shrubs, and other plants, including the physiology of vegetative and other plant multiplication processes, conditions under which such processes take place most satisfactorily, the finding or development of more satisfactory rootstocks for apple, pear, cherry, peach, and other fruits, as well as for ornamental shrubs and other plants propagated by budding or grafting.

Recent data on the nursery industry are lacking. The special horticultural census of 1930 gives the most informing statistics available. The sales during 1929 amounted to nearly 186,000,000 trees, shrubs, and other plants (excluding strawberry and other berry plants). The sales value of this stock was about $95,000,000. As of April 1, 1930, nurserymen had growing some 490,000,000 specimens of the same items of all ages. The American Association of Nurserymen, representing many of the important nurseries of the country, but by no means all of them, at its annual meeting in Detroit in July 1938 reported 68,000 acres of nursery stock in its membership, with a total investment of half a billion dollars in nurseries, greenhouses, packing houses, and the like, on which an annual tax of over $1,000,000 was paid. Relatively little research work directly relating to the nursery problems has been done in this country.

Plan and Progress of Work: The activities under this project are grouped into three work projects: (1) Nursery stock production investigations; (2) nursery stock root disease investigations; (3) farm windbreak investi-

gations. The headquarters for the general project are at the U. S. Horticultural Station, Beltsville, Maryland, and for farm windbreak studies at the U. S. Horticultural Field Station, Cheyenne, Wyoming. Cooperative investigations are in progress in eight States, with agricultural experiment stations, other public institutions, and individuals.

The procedure in the research work has included the growing of a great variety of material of potential value as understocks, selecting the individual that appeared outstanding in any important particular, propagating it and testing its value as an understock by budding or grafting on it a sufficiently wide range of varieties to determine its behavior during the nursery period. If a stock appears to give particularly promising results, a long-time orchard test will be made. This is a typical procedure in the case of a fruit tree understock. Other rootstocks are tested in a comparable manner.

The effectiveness of different methods of propagation with plant material variously handled is also tested. In propagation by cuttings, hormones in different concentrations are applied to cuttings of many different species of plants to determine the influence of the growth substances in stimulating the formation and growth of roots.

In the disease investigations the well-known and generally employed methods of pathological research in plants are followed. Attempt is made to find or develop disease-resistant rootstocks whenever possible.

The farm windbreak studies include the testing of a wide range of tree and other plant material to determine its adaptability to the conditions in the region concerned and its ability to live and grow under those conditions. The effect of different combinations and arrangements of the plant material as influencing its usefulness in breaking the force of the wind is determined by actual test. Studies are also made of the influence of windbreaks on soil moisture, on crop production within their range of influence, and the extent of that range.

Long-time orchard tests of rootstocks for cherry, peach, and apple are showing the definite superiority of certain ones for use in various regions. Selections have been made of a considerable number of new stocks on the basis of tests for winter hardiness, resistance to disease or root-attacking insects, and congeniality with scion varieties.

Practicable methods have been devised for prevention of infection of nursery stock by crown gall and by hairy root by proper handling of bench grafts and other propagation material. Progress has been made in the investigation of root rot and other diseases of the roots of fruit trees.

The usefulness and limitations of certain growth-promoting substances, or hormones, in plant propagation, especially in the case of cuttings difficult to root, has been determined for a wide range of ornamental and other nursery stock plants. Determination has been made of improved winter storage conditions for fall-dug stock and of handling and storage condi-

tions for nursery seeds with respect to maintaining viability or to hastening germination.

Plant material suited for farm windbreak purposes and adapted to the peculiar conditions in the Great Plains area has been assembled from various sources, domestic and foreign. Methods of propagation, of nursery culture, and of transplanting have been worked out. Several hundred cooperative tests are under way of windbreaks adapted to farm use in six States of this region. Careful study is made of the growth behavior of the windbreaks and of their effectiveness in bettering conditions for agricultural production and comfortable living.

Project. 7. Potato Investigations:

Objective: To reduce the cost of producing potatoes through more effective cultural methods, by breeding high-yielding varieties resistant to scab, blight viruses, and other diseases, of better table quality, and superior in other respects; and to determine the causal agents producing diseases, means of spread and of infection, and methods of control, including methods for breeding disease-resistant varieties.

The Problem: Standard varieties of potatoes are grown over wide areas, with great variation in soil and climate and also with great variation in yields. Better results could be obtained by developing varieties capable of uniformly high production under the special conditions of different regions.

Losses from diseases have always been high in potato production. Within the past 20 years, with the more general adoption of control measures, such as spraying and seed certification, the average per-acre potato production of the country has showed a marked and consistent increase. This has been attained at considerable cost for the special control measures; yet, in spite of such costs, disease losses are still considerable. For the 6 years 1931 to 1936, they are estimated to have been more than 61,000,000 bushels annually, or about 18 bushels for every acre harvested in the whole country. Development of varieties resistant to the common diseases would result in decreased losses and in lessened expense of production per unit area.

Consumer demand for a higher-quality product is being manifested in the case of potatoes as well as of other vegetable crops. The great variety of ways of preparing potatoes for the table adds to the requirement for varieties well suited for use in these ways.

Significance: The potato is the most important single vegetable crop produced in the United States. Any improvement in cultural methods, in varieties, or in disease control potentially affects the entire country in the case of a crop grown so extensively and widely. For the five years 1934 to 1938, inclusive, the average annual harvested area was 3,376,600 acres. The average annual production for this same period was 377,568,000 bushels, and the average farm value was $241,876,000.

Plan and Progress of Work: Primary work is conducted at Beltsville, Maryland, at the Potato Experiment Station, Greeley, Colorado, at the Maine Experiment Station at Presque Isle, Maine, and at the Louisiana Experiment Station, Baton Rouge, Louisiana, with production investigations in five other States.

In the National Potato Breeding Program the Department is cooperating with the agricultural experiment stations in a majority of the States, including all in which there is commercial potato production of more than local importance. Seedling stocks are distributed for testing to all of these stations, and new varieties proven to be superior for any region are introduced.

Resulting from the breeding work, nine or ten new varieties have thus far been introduced to the trade. Each of these is superior in certain particulars, including in some such factors as adaptability to some region or regions and in others a high degree of adaptability to widely varying conditions of soil and climate. Most of the new varieties are resistant or tolerant to one or more serious diseases. They all have high table quality, are desirable in shape and appearance of tuber, and possess in high degree other qualities essential to a satisfactory commercial potato. The certified seed production of two of these new varieties (Katahdin and Chippewa) now totals about one million bushels per year.

Diseases caused by fungi, bacteria, and viruses and physiological disorders are all given consideration. Recent effort has been concentrated largely on virus diseases, as a result of which much has been learned about their nature, relationships, means of dissemination and infection, and their occurrence in and effect on the host plant. This information has been essential in the development of varieties resistant to such types of disease, as well as in their more effective elimination from crops grown for seed certification. The progenies developed in the breeding program are tested critically for resistance or susceptibility to all important diseases.

Large collections of breeding material from domestic and foreign sources have been brought together and made available for cooperating workers.

Improvements have been made in various cultural practices, methods of storing and handling seed potatoes, breaking dormancy, proper spacing of seed pieces in planting the new varieties, methods of fertilizer placement, and methods of handling plants to overcome sterility in the production of true seed after hybridizing.

Project 8. Methods of Handling, Transportation, and Storage, and Market Diseases of Fruits, Vegetables, and Flowers, Investigations of:

Objective: To determine optimum stages of maturity of fruits and vegetables for harvesting for different purposes such as local market, shipping to distant market, or storage; to determine limits of usefulness of different methods of precooling before shipment, methods of refrigeration in transit,

methods of supplying heat to prevent freezing during shipment in winter, and the storage requirements and limitations of fruits and vegetables and florists' stocks; to develop control measures for diseases of these products in transit, in storage, and on the market; to determine the value of carbon-dioxide gas treatment before or during transportation or storage.

The Problem: Many of our fruits and vegetables are grown at points far distant from the large centers of consumption. Others, such as apples and potatoes, must be stored for use long after the harvest season. Large losses occur in the handling and storing of these perishable products, principally from decay, blemishes, and deterioration. It is necessary to expend large sums for refrigeration and other means of reducing spoilage. These losses and costs fall heavily on the producer, but they are also reflected in the price the consumer pays.

Work done under this project in recent years demonstrates that much of this loss can be prevented by improved methods of harvesting, handling, shipping, and storage and that costs of present effective treatments can be reduced in many instances. Experience also shows that growers and shippers are eager to get and quick to apply this information.

Significance: This project relates to methods of handling, transportation, and storage of fruits, nuts, vegetables, and florists' stocks. The values of the products affected include costs incident to packing, shipping, and perhaps storage and selling, in addition to the farm values. It is estimated that about 400,000 carlot shipments of fruits and vegetables require special measures as protection against deterioration and decay or injury by cold during transit. Improvements in transportation methods that mean avoidance of losses in transit (including damage payments by the carriers) amounting to but a few dollars per car multiply into impressively large figures rather rapidly. Additional shipments by boat, by motor truck, and in less-than-carload lots require special measures.

Large quantities of perishable produce are held in storage for varying lengths of time to meet consumer needs at other than harvest periods and to insure more orderly marketing. For each perishable product there is a limit to the time it can be successfully held under a given set of storage conditions. Research to make possible a prolonging of the storage life of these products would tend to increase their consumption over a longer period.

Plan and Progress of Work: Headquarters are at Beltsville, Maryland, where laboratory and storage facilities are very complete. Nine other field laboratories are maintained in important production and marketing centers in six states.

Investigations are made to determine satisfactory indexes of maturity so that fruits and vegetables may be harvested at the stage most desirable for local markets, for shipment in the fresh state, or for storage; economical and efficient methods of packing; best methods of precooling to retard ripening in transit or to enable riper and better quality fruits and vegetables to be shipped and to enable shippers to reduce transit re-

frigeration costs; the most effective and economical methods of refrigerating shipments by rail, truck, or boat to domestic and foreign markets; the most satisfactory methods of protecting shipments from freezing in transit without supplying so much heat that the products will become overripe; methods of conditioning perishable products for market prior to shipment, including use of ethylene gas to cause degreening of citrus fruit, and use of disinfectant washes or fumigants to kill decay organisms; methods of removing excessive spray residues, or otherwise satisfactorily cleansing the products.

Experiments are conducted on gas treatments prior to or during storage and transportation as a supplement to or substitute for refrigeration.

Diseases of fruits, vegetables, and florists' stocks occurring during storage, transit, or after arrival on the market are investigated as to causes and favoring conditions and methods of control are developed. Special emphasis is placed on investigations of the storage and transportation requirements as to temperature, humidity, and ventilation, the practical length of storage life, and ripening conditions thereafter.

In determining maturity standards for harvesting, biochemical studies and physical tests are correlated with color, appearance, and other external characteristics. In turn, the commodity is variously tested as to shipping, storage, and other qualities in its various stages of development.

In the transportation tests commodities of known history are loaded into refrigerator cars with recording instruments or with special instruments from which desired records can be obtained by observers who accompany the shipment, and the cars are variously iced, heated, or ventilated, or shipping conditions otherwise modified. Temperatures and other conditions outside the car are recorded. The condition of the commodity is observed on arrival at destination and its subsequent behavior during the marketing period is also commonly noted. Lots variously handled and transported under different conditions are compared.

In the storage tests the same general principles are followed. The commodity of known history is variously handled before storage, is stored under different conditions of temperature and humidity and in various mixtures of carbon dioxide and air, and the results, based on the response of the commodity, are compared.

These investigations have resulted in the development of methods which save the industry many millions of dollars annually. The method of controlling apple scald by use of oiled wraps or shredded oiled paper alone is estimated to save upwards of $2,000,000 annually. The saving in transit refrigeration costs to the California and Arizona citrus industry through adoption of more economical methods of icing cars enroute, developed in the Bureau's investigations, has resulted in an annual saving of upwards of $1,000,000. Savings to pear shippers of the Pacific Coast due to adoption of precooling, heavier loading, and transit refrigeration methods worked out by the Bureau are also estimated to total fully $1,000,000

annually. The reduction in losses from stem-end rot and other decays of Florida citrus fruit due to adoption of the improved methods of harvesting and disinfection developed by the Bureau amounts to several hundred thousand dollars a year.

Most recently, work conducted under this authority has opened the way for savings of at least 20 percent of the value of the Puerto Rico pineapple crop through development of a treatment to control black rot, which ordinarily causes very heavy losses. Losses in handling other perishable crops, similarly due to transit or storage diseases or resulting from freezing, overheating, or other adverse physical conditions, total many millions of dollars annually, which must be shared by producers (in reduced returns) and by consumers (in increased costs). The work done in this Section is directed specifically at the reduction of these losses.

Another important outgrowth of this work was the development of safe methods of cleansing fruits and vegetables from objectionable spray residues so that they can move freely to both domestic and foreign markets. At one time market outlets for these products were seriously threatened on this account.

In the eastern and southern parts of the country, where the prevalence of pear blight makes it impossible to grow better varieties of pears, the Kieffer, Pineapple, and other varieties of this type can be grown but, because of their hard, woody texture as ordinarily handled, they are not greatly prized and usually bring poor returns when sold. Methods of ripening these pears so that they lose their undesirable texture have been developed.

Project 9. Experimental Greenhouse Maintenance:

Objective: (1) To maintain a range of greenhouses at Beltsville, Maryland, as a facility for plant experimentation and research; (2) to provide facilities for testing on an extensive scale the suitability for commercial culture of new varieties of greenhouse crop plants developed in breeding investigations, and for evaluating cultural practices; (3) to produce supplies of plant material of florists' crops, in quantity and uniformity necessary for investigations to improve methods of handling and storing such material.

The Problem: For the most successful and efficient conduct of investigations of diseases of flowers, fruits, and vegetables, physiological studies, and hybridization and plant breeding work it is necessary to have careful control of a number of growth conditions. This can be attained only through the use of greenhouses adapted for supplying a wide range of artificial "climates" suitable for the various types of crops involved.

The breeding work can be greatly accelerated by growing two, three, or perhaps four generations under glass in a year instead of only one, as would usually be the case in the open. With some crops, as potatoes, failure to form or mature seed is a hindrance in breeding investigations. By regulating growth conditions in a greenhouse it may be possible to

induce seed production. Varieties that flower at different times can be handled so as to induce an overlapping of flowering periods, which is necessary for their hybridization.

Much of the experimentation with forcing crops has been handicapped by lack of greenhouse space for extensive comparative trials of varieties or for adequate replications to insure accurate and dependable findings. Commercial forcing of flowers and vegetables is a highly specialized and expensive type of agriculture and presents many complex problems for solution.

Significance: The maintenance of greenhouses under this project contributes to practically all lines of investigational work conducted at Beltsville on fruits, vegetables, and florists' crops, since such facilities are absolutely necessary for the proper conduct of many phases of the work. The use of such facilities greatly hastens the completion of the solution of practical problems of crop production with consequent gain to the growers in securing the benefits of the research at an earlier period.

Much of the investigational work carried on in the greenhouses at Beltsville is basic in supplying plant materials and scientific information for the planning and conduct of research by staff investigators in production centers and by cooperating State experiment station investigators. Such investigations involve crops of all sorts in all sections of the country.

A recent survey shows that in 1938 the wholesale value (amount paid to growers) of cut flowers produced under glass was $120,000,000. The retail value was a much larger sum. Greenhouses for the commercial growing of flowers and vegetables represent a very large permanent investment. Improvements in production practices in this form of plant production are of great importance, and losses from faulty methods can be enormous in the aggregate.

Plan and Progress of Work: This work is closely coordinated with that of the Floricultural and Ornamental Horticultural Plant Investigations project, and essential facilities and cooperation are also given in a large number of investigations throughout the Division of Fruit and Vegetable Crops and Diseases. An extensive and modern range of greenhouses at Beltsville, Maryland, was completed and occupied in the fall of 1939.

Facilities are afforded for cultural studies; breeding and selection for development of improved varieties; disease resistance tests; comparative studies on suitability of varieties for greenhouse culture; production of material on the large scale and with the steady supply necessary for systematic investigations on various methods of handling and storage of greenhouse crop produce. While particular attention is given to crops grown commercially under glass, the facilities are importantly used for investigations on a wide range of fruits and vegetables.

The results of breeding work with chrysanthemums and amaryllis are shown annually in exhibitions attended by professional florists from a number of States as well as by thousands of flower lovers. A large number

of superior varieties have been named and introduced in the trade. Improved varieties of carnations, roses, snapdragons, flowering stocks, Easter lilies, and other florists' crops are in process of final testing for introduction.

Facilities have been supplied for evaluating propagation methods, fertilizer treatments, effects of growth-regulating chemicals, systems of pruning, and exposures to varying periods of light and to different temperatures on a scale that has made possible the securing in a comparatively short time of a large amount of information now in use in commercial floriculture.

It is anticipated that the new greenhouse equipment and the close cooperation with various lines of research at Beltsville will greatly increase the usefulness of this project.

(n) GENETICS AND BIOPHYSICS

The work under this item, for which $25,000 was provided in the 1941 Act, is consolidated in the estimates for 1942 with the item "Cereal Crops and Diseases".

(o) IRRIGATION AGRICULTURE

Appropriation Act, 1941	$133,500
Second Deficiency Act, 1940 (available in 1941 for continuance of work at U. S. Yuma Field Station, Bard, California)	7,000
Total available, 1941	140,500
Budget Estimate, 1942	140,500

PROJECT STATEMENT

Projects	1940	1941 (Estimated)	1942 (Estimated)
1. Crop production investigations under irrigation	$121,249	$109,903	$109,903
2. Quality of irrigation and drainage waters	30,562	30,597	30,597
Unobligated balance	863	- -	- -
Total appropriation ...	152,674	140,500	140,500

WORK UNDER THIS APPROPRIATION

General. The work under this appropriation is concerned with aiding in solving the more important and regional problems relating to maintaining a successful irrigated agriculture. The work is divided into the two projects "Crop Production Investigations under Irrigation" and "Quality of Irrigation and Drainage Waters."

Project 1. Crop Production Investigations Under Irrigation:

Objective: To determine by field experiments what varieties of crops and what methods of crop rotation and fertilization are required for successful irrigation farming, also what quantities of irrigation water are required for the several crops in the western United States.

The Problem: The irrigated lands of the western United States comprise approximately 20,000,000 acres. These lands occur in isolated areas, contiguous to streams, in the arid region. They are surrounded by extensive areas of semiarid land used for dry farming and for grazing. The agricultural enterprises of the irrigated lands and of the surrounding semiarid lands are mutually interdependent. The range lands provide livestock to be fattened for market with forage produced on the irrigated land, and in times of severe drought the irrigated lands provide support for herd and flocks that may re-occupy the ranges when the drought is

broken. Similarly, the operators of dry farms find refuge on irrigated land in case of crop failure and are able quickly to resume operations with the return of favorable conditions. Because the costs of irrigation farming are relatively high, due to the service costs of irrigation water and labor of applying it to the land, the crop yields must also be relatively large. Furthermore, the costs of the construction of works for the storage and distribution of irrigation water require a long period for liquidation, so that the sustained productivity of irrigated land is essential to economic success. These conditions call for a continuing program of agronomic investigation by the Division of Irrigation Agriculture by which to obtain and make available the basic factors of successful crop production on irrigated lands.

Significance: While the irrigated lands lie within the Western States, and these States through their experiment stations are concerned with the problems of irrigation, the Federal Government is also vitally concerned because it has invested through the Bureau of Reclamation more than $200,000,000 in irrigation works. As one means of protecting that investment the Department of the Interior in 1905 requested the Department of Agriculture to establish and support an agency for the investigation of the fundamental problems of crop production under irrigation. Many of these problems have been solved, but others have developed. During the 35 years that these field station investigations have been in operation great progress has been made in the art of irrigation farming. But the long-continued use of these irrigated lands has brought new and intricate problems, such as new insect and disease pests and problems relating to sustained productivity of the soil. It is becoming increasingly apparent that the continued success of irrigation farming is dependent upon continued research. Also the extension of irrigation farming to new and marginal areas presents new problems.

Plan and Progress of Work: The agronomic investigations under this project have been conducted at field stations located on Federal reclamation projects. The facilities of these field stations are used cooperatively for investigations by other divisions of the Bureau of Plant Industry, by divisions of the Bureaus of Animal Industry and Dairy Industry, and by the State experiment stations. The free use of the land and of irrigation water has been provided by the Bureau of Reclamation, and this agency has also contributed some buildings and special aid in land leveling and ditch construction. These field stations are located at Huntley, Montana, Newell, South Dakota, Scottsbluff, Nebraska, Fallon, Nevada, Bard, California, and Hermiston, Oregon. In addition to these, the Division of Irrigation Agriculture conducts investigations at a State experiment station at Prosser, Washington.

The field work includes tests of crop varieties, experiments in crop rotation and fertilization, cooperative investigations on the utilization of crops by livestock, and the measurement of the water requirements of crops. The results of these investigations are reported from time to time in publications prepared by the staff of this Division and by the cooperating agencies. The findings are also made available to

farmers through the Agricultural Extension Services of the States and by visits of farmers to the stations individually and in groups.

Project 2. Quality of Irrigation and Drainage Waters:

Objective: To determine by laboratory and field investigations the dissolved salt constituents in irrigation and drainage waters and in the soil solution, the movement of salts in irrigated lands, and the effects of these salts on the growth of crop plants.

The Problem: Dissolved salts occur naturally in irrigation waters. In many of our irrigation supplies the concentrations range above the equivalent of 1 ton of salts in an acre foot of water. Irrigation water is applied annually at rates up to 5 acre feet per acre. Most of the salts contained in the irrigation water are not absorbed by plants but remain dissolved in the soil solution until removed by drainage. One of the important problems of irrigation management is, first, to insure proper drainage of the land, and then, to apply adequate quantities of irrigation water not only to supply the crop needs but also enough additional water to leach the salts from the root zone and thereby prevent the accumulation of concentrations that are injurious to crop plants. The drainage water from irrigated lands is returned to the streams from which the irrigation water was diverted. Consequently, along streams from which diversions are made the stream water becomes progressively more concentrated in the downstream direction. With the increased concentration of dissolved salts larger quantities of water must be allocated to root zone leaching.

Significance: Approximately one-half of the total supply of irrigation water in the western United States contains so much dissolved salts as to be potentially injurious to the irrigated land unless adequate measures are taken to provide root zone leaching and subsoil drainage. Because of the neglect of such measures in the past, the accumulation of dissolved salts in the root zone has impaired the productivity of approximately 30 percent of our irrigated land, some of which has become completely unproductive and has been abandoned. Investigations of the type here described are essential to obtain information as to the quality of irrigation,subsoil, and drainage waters in irrigated areas, and thus to enable irrigators and irrigation project managers to adopt suitable programs of irrigation to prevent salt accumulation.

Plan and Progress of Work: Investigations under this project are conducted in cooperation with the U. S. Bureau of Reclamation, the U. S. Geological Survey, the Office of Indian Affairs of the Department of the Interior, and corporate irrigation districts. These operating agencies collect samples of irrigation and drainage waters at appropriate gaging stations where the volume of discharge is regularly measured. These water samples with the discharge data are sent to the laboratory where the water is analysed and the quantities of the salt constituent conveyed past each station are computed. From these discharge data and the computations the annual input and output of dissolved salts (the annual salt balance) of an irrigated district is determined. If for any district the salt balance is adverse, i. e., the salt input exceeds the

salt output, then remedial measures in the direction of more copious irrigation and improved drainage facilities are indicated.

These investigations are currently conducted on the Rio Grande in New Mexico and Texas in cooperation with the U. S. Geological Survey, the U. S. Bureau of Reclamation, and the United States Section of the International Boundary Commission, United States and Mexico; on the Colorado River in California and Arizona in cooperation with the U. S. Geological Survey and the U. S. Bureau of Reclamation; and on the Yakima River in Washington in cooperation with the Office of Indian Affairs. In addition to these projects, the Division is currently engaged in making a survey of salinity conditions in irrigated soils contiguous to the Pecos River in Texas and New Mexico as part of the Pecos River Joint Investigation sponsored by the National Resources Planning Board and also in an investigation of the occurrence of boron in irrigation waters of California, Nevada, and Arizona, together with a study of the boron tolerance and boron requirements of crop plants.

(p) MYCOLOGY AND DISEASE SURVEY

The work under this appropriation, for which $45,818 was provided in the 1941 Act, is consolidated in the estimates for 1942 with the item "Plant Exploration, Introduction, and Surveys".

(q) NATIONAL ARBORETUM

Appropriation Act, 1941	$54,587
Budget Estimate, 1942	54,587

PROJECT STATEMENT

Projects	1940	1941 (Estimated)	1942 (Estimated)
1. National Arboretum:			
(a) Maintenance and operation of Arboretum	$26,950	$27,000	$27,000
(b) Planning, developing, and construction of Arboretum	27,537	27,587	27,587
Unobligated balance	100	- -	- -
Total appropriation ...	54,587	54,587	54,587

WORK UNDER THIS APPROPRIATION

General. The work done under this appropriation is to develop a National Arboretum in the District of Columbia in all its branches, including field collections, herbarium, and the like. The work is divided as follows:

Project 1. Maintenance and Operation of Arboretum:

Objective: To establish living collections of all woody plants that will survive under our climatic conditions; to build an herbarium showing representative specimens of the living materials, comparative specimens from other ranges - a general collection of specimens of woody plants of the world with particular emphasis on cultivated plants and their related species; to assemble the necessary library related to this field and arrange for such publications as may be possible.

The Problem: The establishment of living collections is dependent largely upon the development of the plan, which in turn is dependent upon the available funds. Essentially the problem in the whole project is to plan and develop a scheme that will not be entirely consumed in annual maintenance. The development of the herbarium has been continuous and has had the active assistance of various Government agencies.

Significance: A National Arboretum developed here has a wide range of possibilities because this region lies on the boundaries between northern and southern floral types. Such a collection as may be properly assembled here will constitute a basic group, like a Library of Congress collection or a Bureau of Standards type group; it will be a permanent assemblage of plant materials for the use of the geneticist, plant breeder, and forester; its herbarium will become the fundamental standard for botanical work; and the library, if adequately developed, will be the best in the country. Collections such as this are few in the country, and no one collection can adequately cover the whole United States.

Plan and Progress of Work: The plan has been developed in relation to the general plan of the District of Columbia and of the metropolitan areas; it is essentially functional with plant groupings arranged according to relationships and divided only by the requirements of the plants for special conditions of soil, moisture, and exposure. The economies that have been practiced are possible because of the excellent assistance of the Civilian Conservation Corps men and the cooperative assistance of members of the staff of the Division of Plant Exploration and Introduction of the Bureau of Plant Industry.

No development has been attempted that will involve large maintenance or upkeep costs. All the larger areas are either existing stands of trees and shrubs or open area in soil-building programs. Plant collections are essentially in nursery formation to establish them in local soil. Some of the collections are from purchases here and abroad and part are transfers from the Plant Exploration and Introduction Division. None are completed from the botanical point of view.

Staff operation at the Arboretum site involves nursery staff, watchman, and labor under botanical supervision; at the headquarters now in the United States Department of Agriculture are botanists and herbarium workers.

Project 3. Planning, Developing, and Construction of Arboretum:

Objective: To develop the site provided to the best advantage for the growth of the plants necessary to the collection, for the beauty of the development to the ordinary visitor, for the conservation of all variant plant types, and for the preservation of authoritative type materials; and to develop and provide building groups necessary for the administrative and research projects (herbarium, library, etc.), for the nursery and propagation projects, and for general policing and comfort.

The Problem: To create at a minimum of expense for construction (and for later maintenance) a road, path, and trail system that will give access to all parts of the Arboretum; to arrange plant collections in such fashion that the plants will thrive, be representative of their several genera, and be so placed that expansion can be made as new species become available; to build first the functional service buildings necessary for the early stages of construction and plan for such permanent structures and staff as should be supplied to such an institution.

Significance: The significant phases of such planning, developing, and construction as are involved in such a program as this lie essentially in getting the greatest return possible from the funds available; the laying of basic and fundamental elements of design (which can later be given complete development, as in the expensive phases of paving, etc.); to acquire plant materials, both living and herbarium, that will create an authoritative collection; to prepare way for library collection and publications that will serve as large a public as possible.

Plan and Progress of Work: The areas have been carefully surveyed topographically and for soil data, the existing plant population has been recorded, the preliminary road system has been established, and the area has been fenced to prevent theft and nuisance; over 150 acres have been put into soil-building program, and the balance of woody areas have been given preliminary clean-up and thinning; bog areas, not desired as such in future plan, have been tile drained; three ponds have been constructed, nurseries have been developed, four greenhouses (temporary) and frame yards have been completed; preliminary plans, showing basic essentials, have been completed, and a general development scheme for the basic design has been developed from topographic sheets and critical study on the ground. At present it is estimated that the Herbarium contains 81,000 accessioned sheets, with about as many more awaiting mounting and accessioning. The yearly increment is now about 40,000.

(r) NEMATOLOGY

The work under this paragraph, for which $48,961 was appropriated in the 1941 Act, is consolidated in the estimates for 1942 with the next item for "Plant Exploration, Introduction, and Surveys".

(s) PLANT EXPLORATION, INTRODUCTION, AND SURVEYS

Appropriation Act, 1941:	
Transferred in 1942 estimates:	
"Botany" (economic herbarium maintenance and systematic botany studies).........	$31,635
"Mycology and Disease Survey" (all)......	45,818
"Nematology" (all)......................	48,961
"Plant Exploration and Introduction" (all)	224,533
Total available, 1941	350,947
Budget Estimate, 1942	350,947

PROJECT STATEMENT

Projects	1940	1941 (Estimated)	1942 (Estimated)
1. Plant exploration and introduction................	$199,725	$182,154	$182,154
2. Botanical investigations....	77,115	77,453	77,453
3. Rubber production, breeding, and disease investigations	46,343	42,379	42,379
4. Nematology investigations...	48,950	48,961	48,961
Unobligated balance...........	1,963	- -	- -
Total appropriation.....	374,096	350,947	350,947

CHAGES IN LANGUAGE

The estimates include proposed changes in the language of this item as follows:

Plant [exploration and introduction] exploration, introduction, and surveys: For investigations in seed and plant introduction, including the study, collection, purchase, testing, propagation, and distribution of rare and valuable seeds, bulbs, trees, shrubs, vines, cuttings, and plants from foreign countries and from our possessions, and also wild native plants, for experiments with reference to their introduction and cultivation in this country, [and for investigation of their diseases, $224,533] for plant-disease investigations, including nematology, and for plant and plant-disease collections and surveys, $350,947.

The first change involves an amendment in title to include plant surveys because of the inclusion under this item of the plant-disease survey formerly conducted under the subappropriations "Mycology and Disease Survey" and "Nematology", both discontinued in the 1942 Estimates and the funds merged with other subappropriations.

The second change provides for inclusion of authority to study, test, propagate, and distribute wild native plants, as well as plants from foreign countries and our possessions.

The third change provides for the inclusion of authority for plant-disease investigations with respect to introduced and wild native plants, hitherto conducted under "Mycology and Disease Survey", and for the nematological investigations, formerly authorized under the subappropriation "Nematology", both of which are now proposed to be discontinued.

The fourth change provides for the addition of authority to make plant and plant-disease collections and surveys. The new language merely transfers to this item authority for work formerly provided for under the subappropriations "Mycology and Disease Survey", "Botany", and "Nematology", all discontinued as subappropriations.

WORK UNDER THIS APPROPRIATION

General. Work under this appropriation is concerned with the introduction into the United States of plant materials of any type necessary for any phase of agriculture or horticulture; studies of the plant populations of the United States and its possessions, especially as they are part of or related to agricultural crops and crop problems; investigations to determine the possibility of rubber production within the United States and its possessions, with the study of all data related to the production, cultivation, and preparation of rubber, and the acclimatization of introduced rubber plants; investigation of nematode diseases of plants and related problems and study of nematode parasites of insects and other invertebrates; the study of fungi and the building up, care, maintenance, and use of the fungus herbarium now numbering over 400,000 specimens essential in the classification and identification of these organisms; a continuous survey of the occurrence, distribution, prevalence, severity, and spread of plant diseases in the United States; and the solution of problems arising in the commercial production of mushrooms.

Project 1. Plant Exploration and Introduction:

a. Plant Exploration and Collection:

Objective: To attend to all the necessary phases of plant exploration by sending parties into the field for the actual collection of specified materials; to obtain the same by exchange, purchase, or gift.

The Problem: There is general need for a constant world survey by literature and correspondence to find materials necessary or desirable for workers in the United States. There are specific needs, which vary from year to year according to the requests from the crop projects. It may

be possible to handle several such projects concurrently, or it may be necessary to focus all work on one project for a specific fiscal year.

Significance:

(a) More than half of the economic crops of the United States are introduced plants. Since the economic significance of crops developed from introduced plants becomes apparent only in the reports from the crop divisions of the Bureau of Plant Industry and other Government agencies, it is necessary here only to point out the crops on which the specialized attention has been focused within the past ten years. Some of these are tomatoes, potatoes, tobacco, vegetables (especially for the Southeastern States), grasses and other forage crops (particularly for the Great Plains), erosion-control plants, insecticidal plants, and peanuts.

As a result of these efforts the Department has introduced tomatoes that are disease-resistant and that transmit this characteristic to their progeny; potatoes that produce the same results and, in addition, are specially resistant to cold and spring frosts; among vegetables generally, melons, cucumbers, squash that repeat the disease-resistance problems that occur repeatedly with all introduced crops; tobacco strains that are resistant to several of the diseases of economic importance; and grasses of special use for the reestablishment of permanent grasslands in the Great Plains and Rocky Mountains (particularly crested wheat grass).

(b) Miscellaneous plant materials in great variety have been introduced to fill specific needs which have not as yet demonstrated their economic importance. In recent years over 25,000 cinchona plants (the source of quinine) have been raised and sent to Puerto Rico and elsewhere; numerous collections of rice have been received; constant exchange of wheat varieties has been maintained especially with Australia; potatoes for starch, as well as food, have been imported from the Netherlands.

(c) The economic results from such older introductions as the Washington Navel orange, the Durum wheats, wilt-resistant alfalfas, and the soybean indicate the possibilities of such crops under continued crop investigations.

Plan and Progress of Work: Under this project attempts are made to keep in touch with all Federal and State workers in the agricultural field and with a limited number of private individuals; to correlate their needs and to plan the introduction of the plant materials to meet the focused problems of the year. Since it is a program of work which can never be brought to a conclusion, it can only be reported that between 5,000 and 6,000 items per calendar year seems to be the usual output but that the major interest alters with the needs of the research workers.

b. Field Testing of Introduced Plants:

Objective: To safeguard all incoming materials that might introduce foreign diseases or insects; to give preliminary tests under varied conditions; to transfer to specific projects, institutions, or agencies plant material for their research problems; to tabulate data for cultural advices to prospective users.

The Problem: This phase of the work involves the maintenance of an inspection unit, a quarantine unit, four geographically diverse field stations (California, Florida, Georgia, Maryland), constant communication with scientific workers in Bureau, Department and State stations, other scientific groups, commercial horticulturists, and specially trained individuals. All incoming material is examined for health and for botanical identity and is propagated in sufficient quantities to answer preliminary tests (larger propagations being made later to supply workers' needs).

Significance: This project is organized so that with a minimum of effort and expense it can demonstrate that certain plants are valuable only for specific geographic areas or purposes. When this is true the whole program of introduction can be modified accordingly and the introduction of crops of doubtful value forestalled. If plants with special known characters can be provided for use in special problems, time is saved for the research worker.

Plan and Progress of Work: An inspection service is maintained in Washington, D. C., in cooperation with the Bureau of Entomology and Plant Quarantine, and detention facilities are provided at Glenn Dale, Maryland. At all stations propagation and nursery facilities are provided, together with such facilities as may be needed for the special research problems related to these routines. Small collections are maintained to provide propagation materials of slowly maturing plants.

c. Plant Geography and Bibliographic Investigations:

Objective: To maintain a constantly increasing file of data on weather, soils, and plant populations of foreign countries to serve as bases of study of American conditions as related to plant exploration and introduction.

The Problem: In studying the wild relatives of any plant, crop or otherwise, it is necessary to have information as complete as possible as to the factors of growth in its natural habitat.

Significance: From such study it is sometimes possible to select the foreign areas for investigation or limit them to such as are similar to or less desirable than areas in this country for which the introduced plants are intended, in order to obtain the plants most nearly adapted to our conditions. These investigations, together with the Bureau's botanical studies, furnish the sound bases for all introduction work. There is conducted under this head a special project related to Chinese agriculture and literature.

Plan and Progress of Work: This project is based upon a regular review of the current literature and the compiling in card index and other tabular forms of the various data assembled. In the bibliographic field many examinations of Chinese agricultural and horticultural papers have been made, particularly of the older literature. The compilation of data is necessarily continuous. The file of translations of various special Chinese papers number about 300. In addition to this, there are many investigations that are recorded only in correspondence.

Project 2. Botanical Investigations:

a. Herbarium Collections:

Objective:

Economic herbarium maintenance and systematic botany studies. To bring together in closely related form monographic studies of special crop genera; to furnish authoritative information and identification to the various interested Government agencies, such as the Forest Service, Soil Conservation Service, Indian Office, and the National Parks, and such outside agencies as State universities, colleges, special private individuals, and the like; to maintain the herbarium collection necessary to these studies; to publish papers containing results of such monographic studies.

Wild plant improvement. To improve the usefulness of native plants.

Investigations, identification, and collection of fungi. To build up and maintain an herbarium collection of fungus specimens comprising as far as possible all genera and species; to use the collections (more than 400,000 specimens) in the identification of material submitted and in the prosecution of plant-disease investigations; to serve as consulting specialists in the difficult, obscure, and highly technical but industrially and economically important field of fungus classification, nomenclature, and function; and to assist the workers in the Department, the State experiment stations, educational institutions, and elsewhere in their problems with fungi.

The Problem:

In working with any plant-breeding problem it is now apparent that, in addition to the crop species itself the related species and genera must be studied. For this it is imperative that material be named correctly and that the naming be supplemented by comparison with the herbarium material. Correct plant naming has become increasingly imperative for all land-utilization studies in the Soil Conservation Service and other agencies concerned with general plant population studies, with soil surveys, and the like. The maintenance of an economic herbarium is a relatively simple matter, like the development and maintenance of a library.

Wild plants are studied with a view to the selection of the best individuals and the breeding of superior varieties or strains of economic crop importance.

The economic significance of fungi as agents causing plant and animal disease makes their accurate identification a matter of much practical importance. Because of the great number of species of fungi, estimated in excess of 300,000 named forms, two-thirds of which are probably duplicates involving confusion, not to mention varieties within species or undescribed forms and because of the microscopic size of the vast majority of these species, their variability under environmental changes, and many other characteristics, identification is a difficult matter, requiring much technical training and experience, the use of specialized equipment and techniques, and the comparative study of extensive authentic material.

Significance:

The investigation of native grass and legume populations has served as the basis for the revision of some forage and pasture programs, the introduction of foreign species of genera represented here, and reaching decisions with respect to certain types of land development. A revision and study of species of tomatoes brings out the significance of species other than those usually grown. A study of *Allium* (onion) brings to light various species usually not cultivated that can now contribute to the breeding program. Studies of such genera as *Trifolium* (clover), *Melilotus* (sweet clover), and the like bring to notice species not commonly grown but of specific value. Similar studies of citrus, apples, amelanchier, *Rubus*, etc., are in progress and innumerable ornamentals are under observation preliminary to study.

The historical development of the blueberry - first in its usual northern ranges and later in the production of a hybrid race for the South, extending the range, production, and season of this fruit - is a matter of record. This work continues. It is believed that similar progress can be made with various other native plants.

Fungi are the causal agents of thousands of diseases of plants and of many diseases of insects and of the higher animals, including man. They are active agents in the decomposition of organic matter and as such play an important rôle in maintaining the fertility of the soil. They are active agents in the destruction of fruits, vegetables, cereals, provender, and forage products and in the rotting of wood and the decay of timber. They function in many domestic and commercial processes, such as the raising of bread and the curing of cheese, in the manufacture of chemicals, and in numerous industrial fermentations.

Among the higher fungi many species are edible and some are much prized as human food, while others contain such deadly poisons that a fragment may be fatal. The first prerequisite in the utilization, control, regulation, or defense against these organisms, as the case may be, is accurate knowledge of their identity and individual characteristics and life histories. It is the province of this activity, technically known as mycology, to acquire and supply this knowledge. It

functions not only for the Bureau and the Department but its services are available to experiment stations and educational institutions of the United States, to scientists of the Pan-American countries, and to the general public.

Plan and Progress of Work:

An increase in the extent of service identification has resulted from an addition to the staff of botanists, among whom have been divided the plant families, so that determinations may be as rapid as possible. Each man is called upon to identify his special groups. The annual identifications now average about 35,000 per year, which represents the full time of eight men.

Studies are now being made of the possibilities of cultivation in the East of various medicinal plants used by the American Indians. Since cultivation of these plants is almost impossible in their natural locations, a study is in progress in the East where careful observation can be made of the bases of failure. At present only the preliminary germination and nursery studies are under way.

The work of investigations, identification, and collection of fungi is organized under a project leader and five additional professional employees, all located in Washington, where the herbarium is maintained. Members of the scientific staff are occupied in identifying specimens; classifying additions to the collections; advising other workers on technical matters; making systematic studies of special groups; preparing technical descriptions of new species in English with Latin diagnoses, as required by the International Rules; writing technical papers for publication; and, in general, performing all the duties of a service agency having the custody of one of the world's outstanding mycological herbaria. Accessions to the collections in recent years by exchanges, gifts, field collections by the staff, depositions by interested workers and correspondents, and by occasional purchase are shown in the appended table.

Herbarium Accession Table

Year	New Fungus Accessions	Literature References Carded
1936	4,500	17,600
1937	6,000	16,510
1938	8,057	19,678
1939	15,724	27,466
1940	8,249	57,869

b. Plant Disease Survey:

Objective: To collect, record, and promptly distribute timely information on the incidence, identity, and current status of plant diseases throughout the United States; to serve as a national clearing house of plant disease information; to maintain cumulative records of disease incidence and of the losses caused by plant diseases; to study the factors involved

in the rise and spread of epidemics; to make the information obtained promptly and constantly available to agricultural workers, plant specialists, and others for whom it has value.

The Problem: The average loss from plant diseases in the United States estimated over a period of 15 years is conservatively placed at 12-1/2 percent of our crop production. This means that plant diseases exact as toll from American farmers each year one day's labor out of eight, one dollar out of each eight invested in agricultural lands, seed, fertilizers, farm machinery, hired hands, draft animals, and other equipment used for crop production.

Plant diseases present problems in the practice of agriculture comparable in complexity to those in human medicine. The causes in the two fields are equally varied and difficult of identification. Plant-disease producing agents include scores of distinct viruses, hundreds of different parasitic bacteria, and thousands of species of pathogenic fungi, as well as a great variety of unfavorable environmental conditions in soil and air capable of bringing about malnutrition and other forms of physiological ill health. Correct diagnosis is a difficult matter requiring a background of extensive specialized training and experience.

The first prerequisite in successful control of plant diseases is adequate, accurate, and reliable information on their identity, occurrence, distribution, and significance. The Plant Disease Survey attempts to collect and distribute such information on a national basis and to place it in the hands of those engaged in planning and conducting investigations and programs of work. It is the only agency in the United States so engaged.

Significance: Accurate, adequate, and dependable information on the incidence, identity, prevalence, and severity of plant diseases in the United States and the losses caused by them is essential to the intelligent selection, planning, and prosecution of investigations and programs of work. Such data finds application in projects of crop improvement, in the development of superior and disease-resistant varieties, evaluating cultural practices and rotations, developing control methods, studies of deterioration in storage, transit, and market, forecasting production, determining insurance hazards, administration of quarantines, forewarning of the outbreak of epidemics and the timely application of protective measures, planning and carrying on extension programs, the selection of sites for large or small-scale planting enterprises or resettlement projects, and, in fact, in all undertakings where crop production is involved. Plant diseases must be considered and reckoned with among the hazards of agriculture and the more completely their identity and potentialities are known the more successfully can they be dealt with.

Plan and Progress of Work: This work is organized under a project leader, one associate pathologist engaged in field service during the crop season and in related activities for the balance of the year, one assistant pathologist and one junior pathologist who constitute the headquarters' technical staff.

Approximately 200 trained scientists, most of them pathologists in the employ of State colleges and experiment stations, hold appointments as collaborators serving without pay. These collaborators and a substantial number of other volunteer cooperators make observations of plant disease occurrences as opportunity permits and submit reports, current notes, and pertinent comments from time to time as they are able. All reports are preserved with supporting indexes in the cumulative files of the Survey, so arranged as to be constantly and conveniently available for reference purposes to Bureau personnel and visiting workers. Items of current interest are published in the mimeographed Plant Disease Reporter, official organ of the Survey, issued twice a month and sent to collaborators and to about 800 other specialists who ask for this service.

At the close of each year requests are made for reports covering all the plant diseases observed during the season and for estimates of the percentage reduction in yield within the collaborator's territory of several of the more important specified crops due, respectively, to a number of their more common diseases, as well as the total estimated reduction in yield of these crops due to all diseases. These reports are tabulated, summarized, and issued as supplements to the Plant Disease Reporter. Additional supplements to the Reporter dealing with special phases of plant-disease distribution are issued as material becomes available. The project is planned and conducted solely as a service to Department and State experiment station workers and others in need of plant-disease information for official use or for other constructive purposes.

c. Mushroom Investigations:

Objective: To improve cultural conditions, control serious diseases, develop improved varieties, develop artificial compost to replace horse manure, and develop new non-competitive mushroom industries.

The Problem: (a) A reduction of one-third in the market value of mushrooms in recent years has forced increased efficiency in production or bankruptcy. (b) Several serious diseases of mushrooms, some of unknown origin, threaten the crop. (c) The standard commercial variety usually cultivated has several undesirable characteristics; it must be grown at low temperature; it bruises easily; its flavor is inferior to some wild varieties; and it produces too many small mushrooms. (d) The steadily diminishing supply of horse manure, the standard basic material for mushroom culture, indicates an eventual need for a suitable substitute. (e) The successful introduction into the United States of the European truffle, the Japanese Shii-take or tree mushroom, and the Chinese rice-straw mushroom appear to be feasible and desirable. Native wild species of mushrooms with superior flavor exist and their domestication should be attempted.

Significance: The mushroom industry in the United States ranks in annual farm value ($5,000,000) with crops such as cauliflower, cranberries, figs, pecans, spinach, hops, and watermelon. It has higher monetary

value than almonds, lima beans, beets, cucumbers, dates, or olives. The mushroom is a fungus. Its growth is regulated by underlying principles differing from those applying to green plants. Many of them are only partially understood and there is a distinct practical and profitable opportunity for and need of research in the development of improved cultural practices and the distribution to growers of reliable information to guide them. Truffle growing is an established $2,000,000 industry in France. In Japan several million pounds of tree-mushrooms (Shii-take) are grown annually. Both are extensively imported into the United States but might be profitably produced here.

Plan and Progress of Work: Studies of the effect of depth, time of application, acidity, and texture of casing soils have been completed and the results applied by most commercial mushroom growers, with an estimated savings of 2 percent or $100,000 annually. It has been shown that the removal by ventilation of the large quantities of carbon dioxide found to be produced by growing mushrooms prevents the production of malformed and unmarketable crops. The effects of traces of other gases are under investigation. The practice of adding superphosphate as a supplement to manure worked out under this project has given an average 5 percent increase in yield. Horse manure, the material used for raising mushrooms, must be composted (partly decomposed), before it is ready for use. Improvement in composting practice worked out in this project is conservatively estimated to have resulted in a 5 percent increase in yield per unit of bed space, a $250,000 annual return. Studies now in progress promise a saving of nearly half of the manure used in making beds, along with economies in the labor involved.

Studies are in progress on the causes and methods of control of mushroom diseases. The discovery of the low thermal death point of the *Mycogone* fungus has pointed a way to an easy and successful method of control, preventing a 10 percent loss, resulting in a saving of $500,000 annually. Another disease of unknown cause which has recently appeared has this year bankrupted one of the largest western growers. Study of this trouble will be undertaken this winter.

Mushrooms now under cultivation must be grown at temperatures below 65°F. A species now being tested grows well at 80°F. If it proves desirable in other respects, it will furnish a summer supply not available at present in many localities.

A system of composting straw with chemical fertilizers as a substitute for horse manure has been developed which produces a material capable of yielding on the average about two-thirds as many mushrooms per unit of bed space as horse manure. The material in its present state of development has an important practical value in that it acts as an insurance against capital depreciation as a result of a future shortage of manure. Work is being continued.

Truffle oak trees have been imported and planted in cooperative experiments in various parts of the country, adapting methods of culture used abroad. Several years must necessarily elapse before the success of these experiments can be determined. Experiments are also in progress with the morel mushroom.

3. Rubber Production, Breeding, and Disease Investigations:

Objective: To investigate all plants, native or introduced, that might serve as a basis of a commercial rubber industry.

The Problem: There are two groups of plants involved in this study, those known to be sources of commercial rubber (practically all tropical) and those reported to have rubber in varying amounts. The problem with the first group is to adapt them, if possible, to our climatic conditions and then to bring them to production; the problem with the second group is to discover which are susceptible to improvement by cultural practice or breeding to bring their rubber content within the range of commercial consideration.

Significance: The United States uses about 50 percent of the world's rubber production and imports all of its annual consumption, mostly from the Dutch East Indies and Malaya. As rubber has come to be an indispensable part of many industries, the need for the development of a domestic supply is obvious.

Plan and Progress of Work:

Hevea as a source of rubber: In dealing with the purely tropical rubber-producing plants, the project has concentrated its efforts at the U. S. Plant Introduction Garden, Coconut Grove, Florida, where all the commercial rubber-producing tropical plants have been grown. Since only one of these, the Brazilian Hevea, is a serious factor in modern rubber production, most work has been done on that species. Plants have been grown from seed, have seeded, and plants grown from these local seeds are now seeding. This slow process is the natural method of extending climatic range since during the cycles all tender trees are naturally eliminated. From the data so far gathered, it is apparent that Hevea can be grown in portions of Florida and produce good latex. What remains to be proved is the amount of latex per tree per year and the costs as compared to other rubber production. Particular attention has been paid to keeping this planting free from disease, particularly the South American leaf disease. As a supplement to this work, a breeding program has been carried on in cooperative plantations in Costa Rica, using a highly resistant clone as one element in a variety of crossings. As these seedlings become available for study, further breeding can be continued to develop any plant features that need improvement.

Other plants that yield rubber: Hardy rubber-producing plants present another problem. There are innumerable plants in the United States that contain traces or small amounts of rubber. The data from the Edison experiments and additional data based upon our own tests are on file. These serve not only as guides for experimentation but also as deterrents for poorly thought out schemes proposed by correspondents.

Basic work has been conducted with goldenrod, and the best species and the areas of their adaptability are fairly well understood.

Breeding experiments have progressed far enough to determine that 200 to 300 pounds of rubber per acre may be expected. Breeding is under way to bring this to a still higher level. In the meantime, laboratory studies of extraction methods are under way and promising results in producing pliofilm-like materials have just been completed (1940).

4. Nematology Investigations:

a. Plant-parasitic and Related Nematode Investigations:

Objective: To determine practical methods for the control of diseases of plants caused by or related to nematodes; to study the reactions of plants toward nematode attacks, particularly in view of symptoms, of susceptibility, and of immunity; to study the enemies and diseases of nematodes and other natural factors conditioning their control; to study the rôle of nematodes in soil-life, particularly as related to the production of crops.

The Problem: There is a general need for more fundamental information on nematodes. We need more exact knowledge of the organisms themselves, their development, life habits, and their relationship to the hosts and to the entire environment. Minuteness of the orgnisms makes their detection by inspection difficult. The fact that they are soil-carried and that they are very resistant to poisons, heat, drought, and other similar factors make it practically impossible to eradicate these pests. Nematode diseases of plants will therefore persist and need attention for years to come.

Significance: Some of the plant-infesting nematodes are agricultural pests of the worst type.

The root-knot nematode is known as such the world over. It is a greenhouse pest everywhere and an outdoor pest all through the warmer and some of the temperate regions of this country, particularly where sandy soils prevail. It is known to attack some 1,400 different plant species. Annual losses in production of tobacco, cotton, sweet and Irish potatoes, tomatoes, carrots, nursery stock, ornamentals, etc., amount to many millions of dollars. It threatens the seedling industry in various parts of the South. Hundreds of shipments of nursery stock are annually condemned because of root-knot. It prevents the growing of figs commercially in the South. Through deformation of the tubers, carloads of Irish potatoes and sweetpotatoes are rendered unmarketable. In infested localities of Oregon this nematode is said to reduce the seed production of Ladino clover by 50 percent. Not infrequently land, or the production of certain crops, has to be abandoned because of this nematode.

The bulb or stem nematode, the strawberry, the begonia, the chrysanthemum, the sugar-beet, and the meadow nematodes are similar pests, each attacking a number of different hosts, causing direct damage or indirect losses through forcing growers to adopt certain crop rotations, special sanitary and preventive measures, and special cleaning or curative processes (hotwater treatment of various ornamental

bulbs, etc.). In Oregon a young industry, the production of grass seed, is threatened by a seed nematode closely related to the long known wheat nematode. Tons of seeds are galled and made useless, involving losses of thousands of dollars.

There are numerous other nematodes attacking plants; some are as yet little known or proved to be of minor significance. It is only during comparatively recent years that the significance of nematodes as disease agents of crops and other plants has been more fully recognized. This has been a factor in increasing the demands on the Department for assistance in the control of these pests. Another factor has been the increase in shipments of infested plant material during recent years, leading to an enormous increase in distribution of these pests.

Plan and Progress of Work:

(1) Studies on the chemical control of soil have recently shown that a compound of chloropicrin (tear gas) and ethylene dichloride promises to be an effective control for nematodes. Other work in progress includes life-history studies on a variety of parasitic forms, and studies of methods for cleaning infested plants, of the transfer of nematodes from one plant host to another, of immunity and resistance of plants to diseases caused by nematodes, and of the effect of fertilizers in reducing damage caused by nematodes to sugar beets.

(2) In addition to its strictly research activities, this project performs service work for many State and Federal institutions, as it is the only agency of its kind in the United States. Service work includes the examination of sample material, identification of specimens, and frequently the making of surveys. In every instance where it is possible to do so recommendations are given for control. Another type of service work is the testing of nematocides. Many of these chemical preparations are now on the market.

(3) Location of work: Diseases of the character of the present ones are best studied where they naturally occur. This principle is applied so far as possible in the location of the present work (Tifton, Georgia; Salt Lake City, Utah; Sumner, Washington; Babylon, Long Island; Beltsville, Maryland, as permanent locations; Klamath Falls and Astoria, Oregon, as present temporary locations). Another principle of importance in the location of the present work is the consideration that specialists for nemic plant diseases should be at hand in the various regions where most needed for survey and field consultation work.

b. Investigations on Nemic Parasites of Insects and Other Invertebrates:

Objective: To study nematodes infesting insects and other invertebrates in view of their significance as natural controlling factors of such pests (grasshoppers, Japanese beetles, bark beetles, corn earworms, ants, slugs, millipeds, etc.).

<u>The Problem and Significance</u>: Various insect and similar pests are known to be attacked by parasitic nematodes which under certain conditions exert a natural control. Nematodes called mermithids (horse-hair snakes) thus kill and control in certain regions grasshoppers and many other insects and even slugs. Japanese beetles, particularly the grubs, are very effectively controlled by bacterial diseases which are transmitted by nematodes of the genus Neoaplectana. Many other insects (corn ear-worms, ants) are also successfully attacked by them. Bark beetles harbor numerous nemic parasites and in some instances are claimed to be controlled by them. The question is therefore raised as to what degree and how these nematodes may be utilized in our fight against insects and similar pests.

<u>Plan and Progress of Work</u>: Funds and pressure of other activities have restricted this work mainly to cooperative investigations with entomologists and entomological agencies, particularly on subjects of taxonomy, morphology, life history, and routine matters. The preparation of monographs on the mermithids and on the neoaplectanas is slowly progressing.

<u>Special Note</u>: Three agencies of the Federal Government deal with nematodes: (1) The National Institute of Health with nematodes that parasitize man and cause human diseases; (2) the Bureau of Animal Industry of the United States Department of Agriculture, which is concerned with nematodes that parasitize vertebrate animals, particularly domesticated animals; and (3) the Bureau of Plant Industry, which deals with the bulk of the forms: parasites of insects and similar forms, parasites of plants and related free-living forms of the soil and of fresh and marine waters. Since the forms dealt with by this agency belong to entirely separate and different taxonomic groups than those parasitizing man and vertebrate animals, there is no overlapping or duplication of work between this and the other two agencies.

(t) SOIL CHEMICAL AND PHYSICAL INVESTIGATIONS

The work under this item, for which $70,000 was appropriated in the 1941 Act, is consolidated in the estimates for 1942 under the new appropriation title "Soil and Fertilizer Investigations".

(u) SOIL-FERTILITY INVESTIGATIONS

The work under this item, for which $121,622 was appropriated in the 1941 Act, is consolidated in the estimates for 1942 as follows:

"Cotton and Other Fiber Crops and Diseases" (cotton soil-fertility investigations and cotton root-rot soil and fertilizer investigations)		$35,190
"Fruit and Vegetable Crops and Diseases":		
Citrus soil-fertility investigations	$10,145	
Pecan soil-fertility investigations	15,965	
Potato soil-fertility investigations	13,730	
Soil-fertility investigations on truck and miscellaneous crops	4,150	43,990
"Soil and Fertilizer Investigations" (soil management: soil improvement by crops and cropping methods)		20,167
"Sugar-Plant Investigations":		
Sugarcane soil-fertility investigations	$12,100	
Sugar beet soil-fertility investigations	10,175	22,275
Total		121,622

(v) SOIL MICROBIOLOGY INVESTIGATIONS

The work under this item, for which $39,854 was appropriated in the 1941 Act, is consolidated in the estimates for 1942 under the new appropriation title "Soil and Fertilizer Investigations".

(w) SOIL AND FERTILIZER INVESTIGATIONS

Appropriation Act, 1941:		
Transferred in 1942 estimates from:		
"Fertilizer Investigations" (all)	$240,000	(a)
"Soil Chemical and Physical Investigations" (all)	70,000	(a)
"Soil-Fertility Investigations" (soil management: soil improvement by crops and cropping methods)	20,167	(a)
"Soil Microbiology Investigations" (all)	39,854	(a)
Total available, 1941	370,021	
Budget Estimate, 1942	355,021	
Decrease	15,000	

(a) As explained in the opening statement for the Bureau of Plant Industry, the 1942 estimates provide for the consolidation of this work under the proposed title "Soil and Fertilizer Investigations". In the consolidation as indicated in the Project Statement below, $20,167 of the 1941 appropriation for "Soil-Fertility Investigations" is added to the 1941 appropriation of $240,000 for "Fertilizer Investigations", making a total of $260,167. From this total, $22,461 covering biochemical studies is deducted and added to the 1941 appropriation of $39,854 for "Soil Microbiology Investigations", making a total of $62,315. This leaves for "Soil Management and Fertilizer Investigations" for 1941 a total of $237,706, which includes the non-recurring item of $15,000 shown as a decrease for 1942. The foregoing changes are effected in order to consolidate closely allied lines of research.

PROJECT STATEMENT

Projects	1940	1941 (Estimated)	1942 (Estimated)	Decrease
1. Soil management and fertilizer investigations	$221,913	$237,706	$222,706	- $15,000 (1)
2. Soil microbiology investigations	61,994	62,315	62,315	- -
3. Soil chemical and physical investigations	76,155	70,000	70,000	- -
Unobligated balance	1,659	- -	- -	- -
Total appropriation	361,721	370,021	355,021	- 15,000

DECREASE

(1) The decrease of $15,000 in this item for 1942 is due to the elimination of a non-recurring item provided in 1941 for transferring the Fertilizer Laboratory to Beltsville, Maryland.

NEW LANGUAGE

The estimates include the following new language:

> Soil and fertilizer investigations: For soil and fertilizer investigations, including soil minerals, soil organic matter, soil solution, soil physical and chemical investigations, soil microbiology, including the testing of cultures procured in the open market for inoculating legumes, other crops or soil, and if any such samples are found to be impure, nonviable, or misbranded, the results of the tests may be published, together with the names of the manufacturers and of the persons by whom the cultures were offered for sale; for investigations of the causes of soil infertility and the maintenance of soil productivity; and for investigations within the United States of fertilizers, fertilizer ingredients, including phosphoric acid and potash, and other soil amendments, and their suitability for agricultural use, $355,021.

This proposed language merely combines and restates the authorizations formerly carried under the subappropriations "Fertilizer Investigations", "Soil Microbiology Investigations", "Soil Chemical and Physical Investigations", and part of "Soil-Fertility Investigations", all of which are discontinued as separate subappropriations. No authority is intended that is not now included in the items which are proposed to be discontinued.

WORK UNDER THIS APPROPRIATION

General. Work under this appropriation is concerned with (1) technological investigations on methods for the preparation of fertilizer materials and mixtures containing the primary plant food elements--nitrogen, phosphorus, and potassium--as well as secondary and minor elements such as calcium, sulfur, magnesium, manganese, zinc, boron, and copper, and the production of soil amendments, such as liming materials for the correction of soil acidity; (2) studies of the chemical and physical properties of fertilizer materials and mixtures; and (3) the maintenance of soil fertility and the determination of the effects of soil composition, cultural methods, and fertilizer and soil amendment applications on the yields and quality of crops.

Project 1. Soil Management and Fertilizer Investigations:

Objective: To develop new and more efficient fertilizers in order to decrease the cost of commercial plant food, conserve national plant-food resources, and promote soil productivity; and to determine the

fertilizer requirements of specific crops on different soils, as a basis for the economical production of high-quality crops without impairment of the soil for use by future generations.

The Problem and Its Significance: American farmers spend approximately $240,000,000 every year for fertilizers. The fertilizer bill is one of the largest items in the cost of producing a crop in some sections. Any economies in manufacture, if passed along to farmers, are important. Such economies have been made in the past as a result of research, and work now in progress promises to further benefit our farmers through (1) decreased costs - made possible by improved methods of manufacture, greater concentration, and consequent lowering of freight costs; (2) increased efficiency - by improvements in the physical properties of fertilizers and by better methods of application; (3) better knowledge of plant food requirements, and the reactions between the soil and fertilizer materials added; and (4) the opening up of new sources of fertilizer materials - thus assuring American farmers of abundant supplies at prices they can afford to pay.

The soil is our basic resource for the production of food and clothing. The use of fertilizers for supplying soils with necessary plant food is one of the recognized methods of good soil management for the maintenance of soil fertility. Substantial crop increases due to the use of fertilizers make possible the development and maintenance of a permanent and profitable agriculture, which would otherwise be most difficult.

Plan and Progress of Work: Work under this appropriation is concerned with (1) technological investigations on methods for the preparation of fertilizer materials and mixtures containing the primary plant food elements--nitrogen, phosphorus, and potassium--as well as secondary and minor elements such as calcium, sulfur, magnesium, manganese, zinc, boron, and copper and the production of soil amendments, such as liming materials for the correction of soil acidity; (2) studies of the chemical and physical properties of fertilizer materials and mixtures; and (3) the maintenance of soil fertility and the determination of the effects of soil composition, cultural methods, and fertilizer and soil amendment applications on the yields and quality of crops.

Laboratory, greenhouse, and field studies are carried on involving a range of important soil types to determine (1) the plant-food requirements of the principal crops; (2) the deficiencies of the soil to be corrected by additions; and (3) the best methods to be employed for the economical utilization of fertilizers to meet crop requirements.

The work is conducted at Beltsville, Maryland, in laboratory and greenhouse and in the field in cooperation with State experiment stations and other agencies. A memorandum of understanding with the Tennessee Valley Authority provides for cooperative fertilizer

studies whereby information or fundamental data and preliminary experiments on methods of preparation may be taken over and expanded to commercial-scale operations. This has been of considerable service to the Tennessee Valley Authority in their production of double superphosphate and of calcium metaphosphate.

Since the initiation of the fertilizer work, and in large part due to the investigations conducted under this appropriation, the United States is no longer dependent on other countries for its nitrogen and potassium supplies. Productive capacities in both these essential fertilizer elements are now sufficient to meet not only agricultural but military demands. This has always been the case with phosphorus.

The investigations on phosphorus, nitrogen, and potassium made possible the manufacture of more concentrated fertilizer materials. From the more concentrated materials it has become possible to prepare mixed fertilizers of higher plant-food content, with resultant lower transportation and marketing costs, which are reflected in savings to the farmer.

Studies on the application of fertilizers have shown that additional savings can be accomplished. For example, application to row crops, in bands an inch or two to the side of the row and one to two inches below the soil surface, results in better utiliza- by the crops. By the proper selection of fertilizers, better yields, and higher-quality crops are obtained; as in the prevention of scab in potatoes by maintaining the desired acid condition in the soil through the use of ammonium sulphate.

Further Possibilities for Savings

While much has been accomplished in fertilizer production and use, many problems remain to be solved. Some of these are:

(1) Devising more efficient and economical processes for producing potassium nitrate, potassium sulphate, urea, and other materials of proven value;

(2) Production of new fertilizer compounds, such as calcined phosphate, organic phosphates, chlorophosphate, calcium metaphosphate and potassium metaphosphate;

(3) Further improvements in the quality of materials and mixtures to give maximum beneficial effects to crops and soils;

(4) Further improvements in physical condition to facilitate handling, storage, and distribution in the field;

(5) Further increase of the plant-food content of fertilizers and the elimination of fillers to reduce costs of handling, bagging, storage, and transportation;

(6) The utilization of new sources of raw materials, such as low-grade or waste materials and byproducts from industries;

(7) The acquiring of fundamental and statistical information on plant-food transformations in soils and the requirements of plants; and

(8) Employment of the information in preparing fertilizers necessary for the economical production of various crops on different soil types.

Project 2. Soil Microbiology Investigations:

a. Microbiological Investigations:

Objective: To determine the relationship of soil micro-organisms to soil composition, soil type and soil conservation, and to crop production; and to test proposals and products designed for introducing particular organisms or groups of organisms into the soil for improving soil productivity or for the control of soil-borne crop diseases.

The Problem and Its Significance: Each soil type presents a special complex of physical features, chemical composition, reaction, aeration, water supply, water-holding capacity, etc., which favors particular crops and determines a microbial flora differing in numbers, kinds, and interrelations from that of other soils.

In the form of roots at least half of every plant is below the surface of the ground. All crop roots as they enter the soil come into direct contact with micro-organisms varying in number from a few hundred thousand to hundreds of millions to the gram. In the average soil there are millions of bacteria and Actinomycetes, thousands to hundreds of thousands of yeasts, molds, protozoa, and myxomycetes, also plant and animal parasites. These belong to great numbers of kinds or species whose presence and significance are directly related to the kind of soil, the presence or absence of organic matter therein and the type of plant cover or crop plants growing. Many of them are known to microbiologists; others are unknown; most of them are so intimately related to organisms found elsewhere as to require large-scale comparative study in establishing their identity and significance.

Soil Organic Matter or Humus

Soil organic matter or humus is produced by micro-organisms which rot or break down all sorts of animal and plant wastes and crop residues, especially the root systems which penetrate every particle of the top layers. These humic substances contributed to tilth and to water holding capacity and, by their further decomposition under attack of special organisms, add to soil fertility. Along with these rotting processes soil minerals are chemically attacked, thus adding to the complexity of the microbial processes encountered.

Control of end results depends upon comparative studies of total populations under experiment, upon the identification of the component species as active agents in the changes recorded, and such studies of their life histories and methods of activity as will form a sound basis for fostering desirable and restraining undesirable kinds.

Inoculants for Leguminous Crops and Other Purposes

Millions of acres of leguminous crops are annually planted for soil improvement. Added fertility is attained only if each particular crop is able to obtain nitrogen from the atmosphere through the agency of some particular strain of bacteria which causes the growth of nodules upon that species. For that purpose cultures of the organism necessary to inoculate the particular legume have been developed by the bacteriologists, and methods for their handling have been defined. Seed enough to plant about 3,000,000 acres is now annually inoculated with commercial cultures. Standardized tests are applied yearly to all brands of inoculants offered for sale. Aid in the improvement of quality is constantly given where necessary. Continuous study of this group of organisms began in this Bureau in 1901.

Soil Micropopulation

Each type of soil, because of its composition, physical character, and crop history (that is, garden, meadow, forest, bog, etc.), will have a natural or normal aggregate of microbes of many kinds with which a crop root system comes into intimate contact when the plants begin to grow. Plowing, tillage, fertilization, and changes in water supply bring about changes in such populations -- some favorable, some unfavorable. Under intensive continuous cultivation, these organisms rot out and destroy the available organic matter, which is a large factor in good soil conditions. Each type of crop has microbial associates which dominate the population of the soil in immediate contact with its root system. Continuous cropping leads to the accumulation of both desirable and undesirable organisms normally associated with that kind of crop plant. Very destructive root rots in cotton, tomatoes, corn, wheat, etc., have developed under continuous cropping systems and often become dominant over the desirable types. The possibility of reducing, suppressing, or actually destroying these parasites by management favoring the development of normal soil flora is indicated by recent investigations which need to be continued and greatly extended.

Sanitary Factors

Wastes contaminated with the microbes of human, animal, and plant or crop diseases constantly reach the soil. Some disappear quickly under the attack of soil organisms; some persist and make the soil a reservoir of infection. Control of the nature and extent of such infections, usually present to some degree but constantly changing, must eventually form a part of every scheme of soil handling.

Plan and Progress of Work: Work is done in laboratories, greenhouses, and plots about Washington and in the field. Certain phases of the work are cooperative with other crop divisions of the Bureau and with certain State agricultural experiment stations. Cooperation with crop specialists already doing experimental work on other phases of the general problem is indicated as very desirable and is made possible through the use of plots already tested and crops of known antecedent history.

b. Nitrogen-Fixation Investigations:

Objective: To study the groups of soil bacteria actively responsible for fixing nitrogen, including their identification, distribution, metabolism, and mode of operation, as a basis for developing their maximum values as contributing to basic soil fertility, hence crop production.

The Problem: Three groups of bacteria, and perhaps other organisms, are involved in nitrogen fixation: (1) legume nodule organisms, (2) the free-living and aerobic Azotobacter group, and (3) the anaerobic Clostridia. Each type of leguminous crop requires a particular kind of bacteria for successful nodulation. Often these must be supplied and sometimes soil conditions must be corrected. To get the best results from all these organisms, whether naturally present or introduced, we need to know everything possible about their identity, physiology, and definite mode of action in relation to crop plants or to the soil components in which they grow.

Significance: Fixation of atmospheric nitrogen by bacteria is said to supply about 70 percent of the nitrogen required for crop production. A large part of this is fixed by nodule bacteria in the roots of leguminous crops. An undetermined part is fixed by the aerobic Azotobacter group of bacteria. Another part is due to anaerobic bacteria. Studies of the identity, life history, and mode of action of each type of micro-organism active in each of these groups is a necessary background for adapting our cropping methods to use them to the best advantage.

Plan and Progress of Work: Work is conducted along the following lines: (1) the development of a pure-line of legume inoculant especially adapted to favor the development of each leguminous crop; (2) study of methods of cultivation of the organisms and of inoculation of the crops; (3) investigation of soil conditions favorable for maximum efficiency; (4) chemical studies of the fixation process; and (5) studies of the Azotobacter group, its various species, its relation to soil and soil handling, and the nature of the metabolic activity by which it collects atmospheric nitrogen and the possibilities of increasing its usefulness to agriculture by adjustment in farm practices.

Project 3. Soil Chemical and Physical Investigations:

Objective: To determine the physical and chemical properties of soils and of the relationship of these properties to each other and to the

soil parent material; to detect and estimate soil deficiencies and excesses of particular components; and to investigate means of making physical and chemical data more helpful in soil investigations.

The Problem: The soil is an exceedingly complex material. It is also a material of widely varying composition, both with respect to source and climate. Its relation to almost all agricultural problems is fundamental since variations in chemical and physical character markedly influence the adaptability of soils for specific uses. Its investigation is exceedingly difficult and resolves into an almost infinite variety of special problems, each with an individual purpose. Among these purposes may be listed the following as examples: (a) the establishment of relationships between the physical properties of different soils, their chemical composition, and their behavior under cultivation; (b) determination of the chemical basis for the classification of soils as presented in soil surveys; (c) study of soil properties as related to fertilizer application, methods of cultivation, and other means of more efficient utilization of soil; (d) detection and estimation of the varying quantities of both the abundant and the rarer elements in soils, in order to determine soil deficiencies and also the presence of materials injurious to the growth or quality of plants. This list of illustrative problems might be extended almost indefinitely, and, indeed, each agricultural advance presents additional problems calling for solution.

Significance: Whenever systematic agricultural investigations of almost any kind are being made, soil chemistry or soil physics, or both, are involved. A few illustrative cases may be cited:

In the field of soil survey soil-chemistry studies have revealed the various changes through which geological materials pass during soil genesis and the relationship between soil morphology and composition.

Physical composition determines the behavior of soils both with respect to water relations and to the absorption and transfer of heat, and on these, in turn, depends the most economic use of soils.

The development of methods for the determination of soil needs through chemical and physical tests has had remarkable progress in recent years. At least three-fourths of the States maintain services, for the benefit of farmers, involving these tests. There is no reason to believe that the maximum value of such tests and of their interpretation has been reached.

The study of the effect of the presence of minute quantities of certain materials has been of special economic importance. The presence of selenium in soils over large areas has been shown to be the cause of important losses of range animals and of possible injury to persons living in these areas and has pointed the way to more efficient use of such lands. Also, the absence of adequate quantities of boron, zinc, and of other elements has been shown to be responsible for decreased yields of crops in particular areas. It would seem that the importance of such investigations is just beginning to emerge.

Plan and Progress of Work: The work of this project covers two fields--research and service. Examples of subjects on which research work is now in progress are: the composition of soil colloids, with special reference to soil classification; the composition and special properties of soil organic matter; the exchangeable bases and water soluble components of soil; the effects of various soil types on the availability of plant nutrients; the modes and rate of heat transference; the extent to which various minor elements are present in soils, and the effects of their presence on plant growth.

The service work is designed to furnish data, determined by well established procedures, supplemental to and useful for the research work of the Division and, more especially, for research planned in other branches of the Department.

As each line project is completed the results are published. A few of the projects in which definite progress has been made, as illustrated by publication or by submittal of manuscripts, are:

(1) The rate of heat transfer in both dry and wet soils.
(2) The identification of the clay minerals in soils of different groups.
(3) The use and interpretation of rapid soil tests for evaluation of soils and for fertilizer requirements.
(4) The variation in chemical composition and physical character of the soils of the flood plains of the Mississippi River and its main tributaries. (In preparation.)
(5) The detailed examination of a number of groups of related soils. Among these are the Norfolk group, the Dayton group and the Miami group.
(6) The occurrence and distribution of selenium (6 major reports).
(7) The occurrence and distribution of boron, arsenic, barium, and other rare elements.

(x) SOIL SURVEY

Appropriation Act, 1941 ....$275,000
Budget Estimate, 1942 275,000

PROJECT STATEMENT

Projects	1940	1941 (Estimated)	1942 (Estimated)
1. Soil Survey:			
(a) Investigations, classification and mapping of soils in the field	$212,070	$191,462	$191,462
(b) Field inspection of soil surveys and correlation of soil types and series	32,788	30,788	30,788
(c) Adjusting, constructing, and drafting soil maps and charts for reproduction.....................	52,481	52,750	52,750
Unobligated balance..........	1,369	- -	- -
Total appropriation	298,708	275,000	275,000

WORK UNDER THIS APPROPRIATION

General. The work under this appropriation is directed toward the investigation of the nature and origin of soils, their classification in a national system, the indication of their extent and distribution upon maps, and the explanation of their capabilities for adapted crops, grasses, and trees, and their stability, under alternative systems of farm management. The mapping of soil types, and their correlation with the soil and plant research results of the Bureau of Plant Industry and cooperating State agricultural experiment stations is the final step in translating this research for use on individual farms and fields.

Project 1. Soil Survey:

Objective: To classify and map the soils of the United States in order to provide farmers, farm associations, and public agencies accurate standard maps necessary for planning cropping systems and other farm operations and for the rational development of programs for the best use of rural lands.

The Problem: The experience of farmers and the results of agricultural research must be carefully related to soil types so that individual farmers

may apply this useful information to the particular soils on their own farms. There are several thousand soil types in the United States, different from one another in a few or in all of their important characteristics, which determine their usefulness for various crops, pastures, or trees and their response to cultural practices. Methods of soil management that lead to high production and soil conservation on one soil type may be less useful, or even ruinous, on another. For example, some are benefited by terracing, others are not; some are acid and respond to liming, others do not; some in dry regions can be irrigated successfully, others can not be; some are very subject to blowing or washing, others are not. The adaptability of crops, and even varieties of crops, the need of fertilizers to produce good yields and crops of high quality, especially from the point of view of nutrition and the effectiveness of the various tillage methods, are all different on different soil types. The main problem of the Soil Survey is to maintain a system of classification, construct maps of soil types (and phases), and develop descriptions and ratings of soil types in order that these differences may be understood clearly and definitely as they apply to individual fields and farms. To be effective, the system of classification must be carefully coordinated on a national basis so that similar soil types are everywhere given the same names and definitions. Responsibility for classification cannot be divided, but must center in one agency, in this case the Soil Survey.

The land surface of the United States comprises about 3,000,000 square miles. The area surveyed and the best available estimates of soil survey needs, as of July 1, 1940, are given below. Although these figures may not be entirely exact, they represent a recent revision of careful estimates made in cooperation with the States in 1938-39. In addition, detailed surveys are essentially completed for Puerto Rico and Hawaii.

	Square Miles
1. Areas having satisfactory soil maps now, including about 225,000 square miles of relatively old surveys that may require revision, for detailed farm planning	900,000
2. Areas needing detailed soil survey now	935,000
3. Areas needing detailed-reconnaissance soil surveys. (These include those having scattered soils suitable for farming along with others not suitable.)........................	620,000
4. Areas needing reconnaissance surveys. (Much of this includes rough mountainous land, range land, and forest land (non-arable), and needing only general surveys.)..............	520,000

Like all research, costs vary with several factors, but three are especially important: (1) the amount of State cooperation, (2) the requirements of the maps, which are more strict than formerly because of their wide use for detailed farm planning, and (3) the availability of base maps, including air photographs, from other agencies.

<u>Significance</u>: The demand for accurate soil maps has increased several fold during the past 10 years. The agricultural conservation programs alone of the Department of Agriculture, the Tennessee Valley Authority, and the

State agencies are now costing 500 to 600 million dollars each year. In addition, other research work in soils, in crop production, and in farm management costs over 10 million more per year. Hundreds of millions are being advanced by Federal credit agencies and private leaders on farm land. Other hundreds of millions are being spent to irrigate soils in the arid and semiarid regions. It has been demonstrated again and again that the success of these activities, costing about one billion dollars annually depends to a great degree upon accurate soil classification and information.

Farmers and prospective farmers use the soil-survey maps in order to apply the results of agricultural research to their own land. Of great present significance is the State and county planning program sponsored by the Department of Agriculture and the land-grant Colleges. Local county committees of farmers and representatives of Federal and State agencies concerned with land-use planning are developing long-time plans for agricultural adjustment and conservation. Repeatedly those committees are finding their work hampered and unsatisfactory where accurate soil maps are not avilable.

Plan and Progress of Work: The Soil Survey is conducted cooperatively with the appropriate State agencies, especially the State agricultural experiment stations. At least some work has been done in every State and Territory, but more has been accomplished in those States making large financial contributions toward the work. Active research is under way now, for a least a part of the year, in 30 to 35 States. In addition, much work is also cooperative with other Federal agencies.

Men are assigned to survey counties in cooperation with men assigned by the experiment stations. At the present time it costs about $40 per square mile for detailed soil surveys, including the preparation of soil descriptions, productivity ratings, and the necessary map drafting, of which the States are contributing about one-half in the form of services of field assistants and scientists. This means a Federal cost of about $20 to $25 for each square mile of survey, exclusive of printing. The soil-survey work must be coordinated on a national basis so that similar soils everywhere will be given the same names and descriptions in all States. At the same time, there are distinct advantages in cooperating with State scientists to bring their local experience to bear on the problem, thus reaping the benefits of combined local and national experience.

Most surveys have been conducted on the basis of county units. There are a few exceptions, especially in the far West, where only small portions of some counties contain arable land. In the immediate future more work may be expected to be undertaken on larger or smaller areas as determined by the urgency of other Federal programs. The order in which counties or areas are taken up for survey is determined cooperatively with the State and Federal officials in accordance with the relative urgency of land-use problems and the imminence of programs based upon soil maps. Under present conditions only a small fraction of the surveys considered essential by cooperating officials and agricultural planning experts can be undertaken.

(y) SUGAR-PLANT INVESTIGATIONS

Appropriation Act, 1941	$315,000
Transferred in 1942 estimates from:	
"Soil-Fertility Investigations" (sugarcane and sugar beet soil-fertility investigations)	22,275
Total available, 1941	337,275
Budget Estimate, 1942	337,275

PROJECT STATEMENT

Projects	1940	1941 (Estimated)	1942 (Estimated)
1. Sugar beet investigations			
(a) Sugar-beet leaf-spot and root-rot control investigations	$33,713	$33,462	$33,462
(b) Sugar-beet curly-top control investigations, including breeding and other means	95,388	89,445	89,445
(c) Sugar-beet production and breeding investigations	85,152	80,312	80,312
Total, Sugar beet investigations	214,253	203,219	203,219
2. Sugarcane investigations			
(a) Sugarcane cultural investigations	42,590	41,135	41,135
(b) Sugarcane disease investigations	38,417	36,667	36,667
(c) Sugarcane breeding investigations	48,232	49,118	49,118
(d) Sugarcane deterioration in storage, Investigations of	7,136	7,136	7,136
Total, Sugarcane investigations	136,375	134,056	134,056
Unobligated balance	1,647	- -	- -
Total	352,275*	337,275*	337,275

* Includes $22,275 for work proposed for transfer in the 1942 estimates.

CHANGES IN LANGUAGE

The estimates include proposed changes in the language of this item as follows:

For sugar-plant investigations, including studies of diseases and the improvement of sugar beets and sugar-beet seed, [$315,000] <u>sugarcane, and other sugar-producing plants, cultural and production methods, and the improvement and maintenance of soil fertility in relation to sugar plants, $337,275</u>.

The first change provides authority to investigate sugarcane and other sugar-producing plants. This authority is believed to be implied in the present language of this item, but it is desired to make it specific.

The second change provides for the inclusion of authority to study cultural and production methods. Here again it is desired to have the authority for this work made more specific.

The third change provides for carrying on sugarcane and sugar-beet soil-fertility work, formerly done under the subappropriation "Soil-Fertility Investigations", now discontinued as a separate subappropriation, with the funds transferred to activities directly involved.

WORK UNDER THIS APPROPRIATION

<u>General</u>. The work under this appropriation consists chiefly of research on problems connected with the growing of sugar beets, the production of sugar-beet seed, and the growing of sugarcane in continental United States, including the control of diseases affecting these crops. The method stressed in the accomplishment of these ends is the development and introduction of varieties improved in respect to disease resistance and other qualities. Researches are also conducted to discover improved agricultural practice for efficiently securing better stands, better yields at lower costs per crop unit, and a higher quality product. Research of this character contributes to stabilization of production by assuring fairly definite yield expectations, regardless of disease-inducing weather variations, and operates to raise the level of profitability of these crops. Methods developed and results of the research pertaining to sugarcane are also applicable to the sugarcane industry of Puerto Rico, Hawaii, and the Virgin Islands.

Project 1. <u>Sugar Beet Investigations</u>:

<u>Objective</u>: To improve and stabilize sugar-beet agriculture as a whole by reduction of disease losses through the development of disease-resistant varieties and improvement of cropping methods; to develop more efficient methods of production of sugar-beet roots for sugar fabrication and of sugar-beet seed to furnish American farmers adequate supplies of home-grown seed of the new and improved varieties developed in sugar-beet research.

<u>The Problem and its Significance</u>: Low acre yields of sugar beets and inferior quality in many districts result from disease epidemics, from present methods of culture, and from lack of adaptation of varieties to soil and climatic conditions. This crop, involving relatively high production costs, may, in one section of the country or another (dependent on seasonal conditions), become marginal or even unprofitable. In order to maintain it as a stable part of American agriculture, it is essential that ways and means be found whereby the sugar crop, which is subject to chronic price depressions because of world surpluses of sugar, may be produced more efficiently per unit of cultivated area.

Sugar, a low-cost food, is an essential in the national dietary and in time of war a prime military necessity. The Nation depends upon its own home-grown crop for a considerable part of its total sugar requirement. The sugar-beet crop normally occupies more than 1,000,000 acres in 22 States (Michigan, Ohio, Indiana, Illinois, Wisconisn, Minnesota, North Dakota, South Dakota, Iowa, Nebraska, Kansas, Montana, Wyoming, Colorado, Texas, New Mexico, Idaho, Utah, Nevada, Washington, Oregon, and California). Nearly 10,000 additional acres in Tennessee, Colorado, Texas, New Mexico, Arizona, Utah, Nevada, California, Oregon, and Washington are used in the intensive sugar-beet seed production enterprise.

In the great majority of States, sugar-beet growing has an important and almost irreplaceable part in the cropping system. Capital investments in farm lands, farm equipment, irrigation systems, factories, factory equipment, transportation, and power facilities directly concerned in sugar-beet production and fabrication of beet sugar amount to at least $400,000,000. Capital investments in subsidiary industries furnishing supplies and service, and in the livestock industry utilizing sugar-beet byproducts, greatly increase this figure.

Fabricated products, refined sugar, beet pulp, and molasses of the 1939 sugar-beet crop had a value of approximately $100,000,000. The sugar beets on the farm were worth about $60,000,000; the beet tops had a value on the farm for feed of more than $5,000,000; and sugar-beet seed had a farm value of $1,100,000.

Diseases Take Huge Toll

Epidemic outbreaks of <u>Leaf Spot</u> (<u>Cercospora beticola</u>) in the humid area and in irrigated districts east of the Rocky Mountains (involving a total of about 600,000 acres) periodically reduce yields and quality to a point unprofitable for farmer and factory. The average annual loss from this disease in one factory district or another amounts to more than $1,000,000 and, in many seasons, far exceeds this. The general effect is to make both crop production on the farm and factory output unsatisfactory in the frequently recurring leaf-spot or "blight" years. Research results give definite indication that these losses may be reduced.

<u>Root rot</u> and seedling diseases, especially in Michigan, Ohio, Indiana, Iowa, Minnesota, and other States in the humid area, reduce stands seriously. The general average of stands in a district may be

only 50 to 60 percent of a full stand, the net effect being idle field space and low, unprofitable yields. Losses of mature roots in the field or in the storage pile because of root rot may amount to 5 to 10 percent of the harvested crop and represent a serious inroad on an already reduced yield.

Curly top, a virus disease brought from surrounding desert areas to fields of sugar beets, beans, tomatoes, and other plants by the beet leaf-hopper, in which plants the insect breeds and overwinters, has for more than three decades been a limiting factor in crop production in the western United States. In affected areas (more than 400,000 acres) continuance of the sugar-beet industry depends upon maintenance and improvement of curly-top-resistant varieties.

Domestic Seed Production

Sugar-beet seed investigations are an all-important factor in making possible efficient seed production of new varieties in adapted areas of the United States, whereby these improved sorts may be supplied the farmer promptly and in adequate quantity. Formerly most of the seed for sugar beets was imported from Europe. We must produce the seed of our own improved varieties in order to control our own disease and production problems.

Plan and Progress of Work:

Leaf Spot Control

The decisive showing that strains improved in leaf-spot resistance can be obtained has caused investigations for control of this disease to center on disease-resistance breeding. New leaf-spot-resistant introductions, notably U. S. 217 and U. S. 200 X 215, have been released as varieties superior to European brands. Disease-resistance breeding and selection are conducted at Arlington, Virginia, and Fort Collins and Rocky Ford, Colorado. Evaluation tests of new, improved varieties to replace the first introductions continue at field stations at East Lansing, Michigan, Holgate, Ohio, St. Paul, Minnesota, Scottsbluff, Nebraska, and Fort Collins and Rocky Ford, Colorado.

Root Rot

Seedling diseases and attendant root rots, continue to be a serious problem, especially in the humid area. Attempts to select resistant forms are not, as yet, conclusive but have promise. At East Lansing, Michigan, and Holgate, Ohio, seed treatment, phosphate application, soil-water content, and field sanitation measures are being tested to determine possible methods for disease control.

Curley-top Control

Definite advance has been made toward the goal of fully curly-top-resistant sugar beet varieties. Beet crop failures because of

curly top were common before 1935. In southern Idaho, for the period 1935 to 1939, the 5-year average yield of one factory district has been 14.6 tons per acre. The average yield for the 5 years preceding was 10.3 tons. Under heavy attack of curly-top, the best varieties are now reduced about 25 percent below their full potentialities, a sharp contrast to previous complete failure.

Strains of the curly-top virus capable of inflicting serious loss even on highly resistant strains have been found. Varieties now sufficiently resistant may need to be replaced if a change in the disease strain present influences them adversely. Breeding investigations at Salt Lake City, Utah, with subsidiary field trials at Twin Falls, Idaho, and at Davis and Riverside, California, have resulted in a number of progressively improved curly-top-resistant varieties.

The objective of eliminating by 1940 the threat of crop failure because of curly top from nearly all western sections has been attained. Measurable losses still occur, as noted above and there is need for further selection and breeding to produce even better adapted strains to meet specific situations. Maintenance of high curly-top resistance coupled with high yield and improved quality, and at the same time the production of a non-bolting, mildew- and rust-resistant type not subject to root rot, imposes a heavy burden on the breeder. The success so far attained forecasts a continued nearer approach to this ultimate goal.

Agronomic Studies

Sugar-beet production investigations are carried on at East Lansing, Michigan, Holgate, Ohio, St. Paul, Minnesota, Scottsbluff, Nebraska, Fort Collins, Colorado, Salt Lake City, Utah, Twin Falls, Idaho, and Davis and Riverside, California. Definite progress has been made; new and improved cropping practices have been tested and other agronomic studies carried on.

Breeding investigations, centering on size and sugar content, are conducted at Arlington, Virginia, St. Paul, Minnesota, and Fort Collins, Colorado.

Seed production studies are conducted at State College, New Mexico, Salt Lake City, Utah, Davis, and Riverside, California, and Corvallis, Oregon, in cooperation with State agricultural experiment stations. These investigations emphasize improvement of methods of production, fertilizer practices to be employed, and the choice of an environment suited to a particular variety in order to insure that all plants in a population will produce seed.

Project 2. Sugarcane Investigations:

Objective: Control of diseases affecting sugarcane, including mosaic, red rot, and chlorotic streak, development of improved disease-resistant varieties suitable for culture under varying climatic and soil conditions, improvement of cultural and fertilizer practices, and development of means for reducing losses in harvested cane; all in the interest of stabilizing production and insuring more economical production of this

crop, with resulting increased cash income to farmers engaged in producing it.

The Problem: Maintenance of economical and profitable production of sugarcane in the United States necessitates constant control of prevailing diseases, breeding and development of improved disease-resistant varieties suitable for culture under the varying climatic and soil conditions, and correlated development of improved cultural and fertilizer practices and of means for preventing or reducing losses in harvested sugarcane. The problem is accentuated by the occurrence from time to time of new diseases introduced from other countries and especially by the sudden occurrence of virulent new strains of prevailing disease organisms which, if not controlled, cause disastrous losses in commercially grown varieties which have proven resistant to injury from previously known strains. Constantly maintained disease-control measures and continued development of improved varieties of sugarcane suitable for commercial culture are, as in all countries in which sugarcane is grown, essential for maintaining the industry on a profitable basis.

Significance: This project directly serves sugarcane producers in Louisiana and Florida, in which cane is grown both for sugar and for sirup production; in Georgia, Mississippi, Alabama, South Carolina, Texas, and Arkansas, in which it is grown for sirup production; and in Puerto Rico. In the Southern States in 1939 about 260,000 acres of land were utilized for sugar production, more than 100,000 acres for sirup production, and about 20,000 acres for production of seed cane. In Puerto Rico about 300,000 acres are utilized normally. The welfare of approximately 1,000,000 people (200,000 in Louisiana alone) living in these cane-producing areas is directly or indirectly dependent upon the crop. About $330,000,000 are invested in land, transportation and milling equipment, implements, etc.

Incidental service features of the activities under this project are extended to the sugarcane industry of the Territory of Hawaii, which has capital investments of about $175,000,000 and in which sugarcane disease and cultural problems resemble those in the above-mentioned areas. Effectively safeguarding and maintaining this important industry and the livelihood of the great number of persons who are dependent upon it calls for prosecution of work under this project because of the ever-shifting disease hazards and other problems which can not be coped with by individual farmers.

Plan and Progress of Work: The plan of the work comprises a closely related program of specialized research and investigation, the purpose of which is to safeguard the valuable sugarcane industry and to maintain it on a high level of productivity and profitability. Field stations are maintained at Canal Point, Florida, Houma, Louisiana, Cairo, Georgia, Meridian, Mississippi, Summit, Panama Canal Zone, and Arlington Farm, Virginia.

Sugarcane Industry Restored

An outstanding example of accomplishment is the reconstitution of the Louisiana sugarcane industry by means of disease-resistant varieties of cane. The five-year average production of sugar, reflecting the per acre yield of cane during the period 1924-28, dropped because of a recently introduced virus disease to 95,400 tons per year, compared with the average of 280,000 tons for the previous 20 years and a maximum in any one year of nearly 400,000 tons. Restoration to an average of 380,000 tons per year for the period 1934-38, which exceeds the best previous five-year period, is directly attributable to research under this project.

Corresponding reconstitution of the industry throughout the States in which cane is grown for sirup production was accomplished by the introduction of disease-tolerant varieties suitable for culture in those States in place of the old varieties which could no longer be grown profitably because of prevalence of the virus disease. Another important accomplishment is the replacement in Louisiana of an extensively grown variety which, because of its having been devastated in 1930 by the sudden occurrence of a new strain of a fungous disease, could no longer be grown profitably. Its replacement by resistant varieties is estimated to have resulted in an annual saving of $1,000,000.

(z) TOBACCO INVESTIGATIONS

Appropriation Act, 1941 .... $140,544
Budget Estimate, 1942 140,544

PROJECT STATEMENT

Projects	1940	1941 (Estimated)	1942 (Estimated)
1. Tobacco investigations:			
(a) Cigar binder and filler production investigations	$5,700	$5,717	$5,717
(b) Flue-cured tobacco production investigations	27,824	26,812	26,812
(c) Burley tobacco production investigations	9,090	9,235	9,235
(d) Maryland tobacco production investigations	6,355	7,860	7,860
(e) Dark air-cured tobacco production investigations	2,278	2,400	2,400
(f) Tobacco disease investigations	51,372	51,402	51,402
(g) Breeding and growing high-nicotine tobacco for use in insecticides	10,016	10,050	10,050
(h) Tobacco breeding and physiological investigations	38,082	27,068	27,068
Unobligated balance	851	- -	- -
Total appropriation	151,568	140,544	140,544

WORK UNDER THIS APPROPRIATION

General. Work under this appropriation is concerned with improving the quality and lowering the cost of producing American-grown tobacco.

Project 1. Tobacco Investigations:

Objective: To lower production costs and to increase the acre value of tobacco by improving methods of growing, curing, and handling the crop.

The Problem and its Significance: At present the average tobacco farmer can only occasionally secure a fair margin of profit on his crop because he is unable consistently to produce at reasonable cost a satisfactory output per acre of the better grades of leaf, quality rather than total yield being the principal factor. This is an especially important matter

under a program of controlled production. The problem to be solved is complex because of the many factors which influence quality. The more essential phases are: (1) Development of sufficiently simple, inexpensive, and effective methods of disease control; (2) improvement and standardization of the varieties of tobacco for production of the several commercial types; (3) improvements in management of plant beds under conditions which have recently developed; (4) determining the best soil types and systems of soil management; (5) working out the most effective methods of fertilization; and (6) developing improved methods of curing and handling. Culture of tobacco for insecticidal purposes is a special problem.

The tobacco crop of about 1,400,000,000 pounds, with a farm value of nearly $300,000,000, is grown on 1,600,000 acres distributed mainly through fifteen States. Tobacco manufactures yield an annual Federal revenue of over $500,000,000.

Diseases reduce the value of the crop each year by 10 to 20 percent. In the South probably 500,000 acres of tobacco are planted on <u>root-knot</u> infested soil, with a loss of $5,000,000 to $10,000,000 annually; in central North Carolina <u>Granville wilt</u> causes such losses that it has reduced by one-half the value of the finest flue-cured tobacco soils, and the disease is spreading; in the Southeastern States <u>blue mold</u> costs the growers several million dollars in additional seed beds planted in an effort to cope with the disease; in Tennessee, Kentucky, and Pennsylvania <u>wildfire</u> causes in epidemic years a loss of $1,000,000; <u>black shank</u>, a new and destructive disease, is rapidly spreading in the South; <u>black root-rot</u> seriously injures the crop in northern areas.

Numerous strains and varieties of tobacco are being grown, many of which are disease-susceptible and in any case produce leaf of mediocre quality. Good woods land is no longer available, so plant beds must now be placed on old land in the open, which introduces new weed seed and nutrition problems. With respect to quality, tobacco is highly sensitive to even slight differences in soil conditions, both physical and chemical, and one of the most pressing needs is to discover the exact nature of the factors involved, so that they may be properly controlled. Successful systems of cropping and management must be developed on the basis of (1) specific effects of preceding crops on tobacco quality, (2) their relation to disease control, and (3) their ability to minimize effects of unfavorable weather conditions, including soil-erosion damage.

More than half of the tobacco crop is grown on light soils requireing expensive fertilization, and lack of definite information as to quantities of essential plant food elements needed, especially those previously neglected in fertilizer practice, is costing growers large sums each year in impaired value of the crop. Unsatisfactory methods of air curing, without control of conditions, cause important losses each year, and in the flue-curing process there is urgent need of perfecting heating systems adapted to the use of coal or oil instead of wood as fuel and affording better curing conditions. Nicotine, a valuable

insecticide, is at present obtained only from tobacco by-product and low-grade leaf.

Plan and Progress of Work: Tobacco culture is highly specialized, and each distinctive type presents special cultural problems because of varying standards of quality and regional differences of soil, climate, disease distribution, etc. Cooperative experiments are carried out with the agricultural experiment stations of the tobacco-growing States of Massachusetts, Connecticut, Pennsylvania, Maryland, North Carolina, South Carolina, Georgia, Tennessee, Kentucky, and Wisconsin, and no independent field stations are maintained.

The work on disease control includes (1) study of disease development and the causal organisms, (2) investigation of crop rotation and cultural practices in relation to disease occurrence and control, (3) development of sprays, gas treatments, and other chemical control measures, and (4) breeding for disease resistance. Suitable rotations have been found decidedly helpful in the control of root-knot and Granville wilt. Effective spray and gas treatments for blue-mold control have been developed which have been found to be applicable to all types of tobacco. Improvements in these measures, making them simpler and more effective are now in prospect.

Progress has been made in use of chemicals for soil sterilization in plant beds. Valuable disease-resistant breeding stocks have been obtained from foreign tobaccos, and certain wild species and work is well advanced in developing root-rot resistant flue-cured, burley, and cigar varieties, black-shank resistant flue-cured varieties, and mosaic-resistant Maryland, flue-cured, and burley varieties. Flue-cured varieties resistant to root-knot, Granville wilt, and blue mold also are being sought.

Cigar Types

In cigar-tobacco production investigations conducted in Massachusetts, Connecticut, Wisconsin, and Pennsylvania, one of the most urgent needs is to discover practical means for increasing the potash content of filler tobacco, which is essential to needed improvements in smoking qualities as well as for increasing resistance to wildfire disease in the field. This is an important problem in its application also to other tobaccos grown on heavy soils, including burley, which cannot be met by ordinary methods of fertilization. A root-rot resistant strain of Havana Seed, which is being developed, promises to replace all other strains in the Connecticut Valley.

Magnesium Pays on Flue-Cured Tobacco

In the flue-cured tobacco production investigations emphasis has been placed on several angles of the fertilizer problem, and important improvements in tobacco fertilization have been effected. For example,

large losses on light soils have been eliminated by introducing the use of small quantities of magnesium in the fertilizer and by control of the quantities of chlorides applied both in the field and in plant beds. It is essential that the functions of each essential element in influencing yield and quality be determined, and at present special attention is being given to elements not previously recognized as of importance. Advances are being made in improving the flue-curing procedure, and very satisfactory results have been obtained with the thermostatically controlled stoker for use of coal instead of wood.

More Nitrogen for Burley

In burley tobacco production work cropping systems are being sought which will meet the threefold requirement of, (1) producing high-quality leaf, (2) aiding in the prevention of root-rot damage, and (3) protecting against soil erosion. It is being found that heavier fertilization, particularly an increased supply of nitrogen, is required for best results.

Weeds Double Value of Maryland Tobacco

In Maryland tobacco-production studies remarkable improvement in quality has been obtained in growing the crop after a weed fallow, the value of the tobacco being almost doubled. It is important to determine the exact cause of this improvement, for probably the same result could then be obtained by other, more direct means. Successful introduction of high potash fertilization has increased the value of the crop by 25 percent or more.

Special Varieties for Nicotine

Varieties of rustica tobacco have been developed which yield upward of 150 pounds of nicotine per acre when grown by specially devised methods, as compared with less than 75 pounds in ordinary tobacco. These varieties are being further improved by breeding.

(aa) RUBBER INVESTIGATIONS

Second Deficiency Act, 1940 (available for fiscal year 1941 and until expended) $500,000
Budget Estimate, 1942 .... - -

PROJECT STATEMENT

Project	1940	1941 (Estimated)	1942 (Estimated)	Decrease
Special rubber investigations: Surveys and investigations directed toward the development of rubber production in the Western Hemisphere:				
Bureau of Plant Industry ...	- -	$278,716	$124,355	- $154,361
Office of Foreign Agricultural Relations	- -	20,000	20,000	- -
Total obligations	- -	298,716	144,355	- 154,361
1941 balance available in 1942..	- -	+201,284	-201,284	- 402,568
1942 balance available in 1943..	- -	- -	+56,929	+56,929
Total appropriation	- -	500,000	- -	- 500,000(1)

(1) The special appropriation of $500,000 provided in the fiscal year 1941, will be obligated in the fiscal years 1941 and 1942, with a balance of $56,929 to be available in 1943, as indicated on the foregoing project statement.

LEGAL AUTHORIZATION

This work is provided for by the following item contained in the Second Deficiency Appropriation Act, 1940, under a "Bureau of Plant Industry" head:

> Rubber investigations: To enable the Secretary of Agriculture to conduct investigations directed toward the development of rubber production in the Western Hemisphere, including production, breeding and disease research; surveys of potential rubber-producing areas; establishment and operation of experiment and demonstration stations in suitable locations; acquisition of land for such purposes; construction and equipment of necessary buildings; travel; purchase, maintenance, operation, and repair of motor-propelled and horse-drawn passenger-carrying vehicles; employment of guides, translators, and

other assistants by contract or otherwise; medical services; books, periodicals, and newspapers; rent; printing; and for all other necessary expenses, including personal services and means in the District of Columbia and elsewhere, fiscal year 1941, $500,000, to be immediately available and to remain available until expended: Provided, That the Secretary of Agriculture is authorized to transfer such sums as he may deem necessary to other Government agencies cooperating or assisting in such investigations.

WORK UNDER THIS APPROPRIATION

General. The work under this appropriation is directed toward the investigation of rubber plants and methods of rubber production which will enable both plantation companies and individual growers to produce rubber in the Western Hemisphere in competition with existing Oriental sources of supply. This includes surveys of potential rubber-producing areas and production, breeding, and disease research. High-yielding strains of rubber-producing *Hevea sp.*, and particularly strains resistant to the serious South American leaf disease, are necessary in order to compete successfully with the low-cost labor of the Orient. The development of disease-resistant, superior strains of rubber trees tested for yield and adaptability and the distribution of these improved strains to cooperating countries and private agencies, together with advice and assistance in determining the best methods of producing rubber under the conditions to be found in tropical Latin America, will be an important contribution of this program to the general problem.

Project 1. Rubber Investigations:

Objective: To conduct investigations of rubber production in the Western Hemisphere looking toward the development of a source of rubber close to the United States and not subject to international restrictions or liable to interruption in periods of war and other international upsets; to aid indirectly in the establishment of a more complementary, balanced trade between the United States and Latin America by encouraging production of this noncompetitive farm product.

The Problem:

(a) The nature of the problem. The Para rubber tree, *Hevea brasiliensis*, is the source of more than 96 percent of all the rubber produced in the world. This tree is native to South America, but was taken to European possessions in the East in 1876, and now 97 percent of the world's rubber is produced in that area. Past surveys have shown that climatic conditions and soils in many areas of the American Tropics are suitable for the production of rubber. However, there exist certain limiting factors when rubber is grown in plantations in the way of increased disease hazards and inadequate labor supply which heretofore have prevented extensive cultivation of rubber in American countries. The present types of high-yielding clones and the disease factor still seriously limit the extensive production of

rubber in Latin America, and the lack of large supplies of labor is a limiting factor insofar as present-day plantation methods are concerned. To initiate large-scale rubber production in the American Tropics it is necessary that these limiting factors be recognized that new selections of trees be developed which will be resistant to the attacks of the leaf disease and that new methods of production be developed adapted to the labor supply available and to the higher costs of labor in the American Tropics. An advantage which we enjoy in relation to rubber plantings in the East is that we are able to take immediate advantage of the improved strains which have been developed but which were not available at the time the majority of the plantings in the East were established. At the present time over 80 percent of the rubber being grown in the East Indies consists of low-yielding, unimproved stocks capable of producing only about 400 pounds of rubber per acre per year even under the most favorable conditions. Superior strains now available for initial plantings in the American Tropics may be expected under favorable conditions to yield at least 1,000 pounds of rubber per acre per year, and there is reason to believe that even greater yields may be obtained. Our problem is to adapt these trees to local conditions in Tropical America and to propagate them in such quantity that any growers contemplating the starting of rubber plantations in Latin America may have at least initial stocks of superior strains adapted to their local conditions.

(b) The extent of the problem. The tropical areas of the Western Hemisphere extend from southern Mexico to Brazil and Bolivia and include portions of sixteen Latin American Republics. In this area there is a great variety of soils, climates, and native populations. General surveys are available denoting areas which might be considered for rubber production. Surveys of soils, climatic records, transportation, native populations, and economic conditions were made by the United States Department of Commerce in 1924 and 1925, and extensive data are available from other sources. However, these surveys point out only general conditions and need to be supplemented by specific surveys, intensive experiments, and extensive propagation of high-yielding clones for distribution as initial propagating stocks to interested planters if a rubber-producing industry is to be initiated.

Heretofore the investigation of the South American leaf disease has been limited to the pathogenic organism. Studies of the host in relation to the disease and the factors of disease resistance and of the effect of climate, altitude, soil, and biological factors on the severity of the disease have not been given adequate study. In connection with this investigation of the rubber-producing possibilities of the Western Hemisphere, it is contemplated that experimental plantings will be made in cooperation with many or all of the Latin American countries which contain areas where soil and climate appear favorable for rubber production. Under this wide variation of conditions it will be possible to determine all of the ecological factors which interact to increase or decrease the susceptibility or resistance of the host tree to this disease.

Labor conditions in all these areas are different from those in the East, and each area will be found to differ in some degree from the others. Extensive experiments will be necessary to adapt present methods of rubber production or to develop new methods suited to the local population and to local conditions in each area.

Significance: Rubber is the most important agricultural product needed in our economy which is not produced in the United States. At the present time the United States uses over 50 percent of all the rubber produced in the world, all of which must be imported, 97 percent from areas on the other side of the world where in normal times international restrictions serve to increase the price of rubber, and at such a distance from the United States that any international upset might seriously decrease or entirely cut off our supplies. In the past few years international agreements among the producing countries served not only to increase the price of rubber but to decrease the stocks of rubber so that at one time less than 3 months' supply of rubber was on hand in the United States to meet any possible contingency in the way of interruption of new supplies. In addition, our international trade directly with the producing areas has been largely unbalanced due to large purchases of rubber and relatively small exports from the United States to those areas. The development of a large rubber-producing industry in the Western Hemisphere would serve to broaden the area of production and to that degree to restrict the possibility of international agreements as to production quotas and the possibility thereby of price control. A more important factor is that an appreciable production of rubber could be established close to the United States where ocean lines of communication would be less liable to interference by European or Asiatic conditions. At the present time the trade relations of the United States and the Latin American Republics are limited by the ability of the Latin American countries to produce goods which are non-competitive with goods produced in the United States. The extension of the cultivation in Latin America of agricultural products also produced in the United States results in closer trade relations with European countries rather than with us. Rubber, because of the large consuming demand in the United States, represents the most important immediate agricultural enterprise which can be encouraged in Latin American countries and which will result immediately in increasing trade relations with the United States, opening up to a greater degree than heretofore has been possible a Central and South American market for manufactured goods and agricultural products produced in the United States.

Plan and Progress of Work:

Bureau of Plant Industry: A series of surveys is being conducted in Central and South America by parties of specialists long experienced in tropical agriculture and familiar with plantation rubber culture in the East as well as conditions, including diseases, affecting rubber in Tropical America. Surveys have now been completed and preliminary reports received on Peru, Panama, Costa Rica, Honduras, Guatemala, and parties are in Ecuador, El Salvador, Bolivia, and

Venezuela. Surveys in other Latin American countries will follow in the near future. In connection with these surveys experimental plantings have been made in Panama, Costa Rica, Honduras, and Guatemala, and progress has been made in assembling at these points high-yielding improved strains of rubber trees from the Philippine Islands and from special collections made by field parties in Tropical America.

Further surveys by the field parties will facilitate as quickly as possible the establishment of additional plantings and an experimental station in a disease-free area essential as a repository for plant materials to be collected by the survey parties and for the propagation, study, and distribution of apparently superior rubber plants for cooperative tests. This material, handled under strict quarantine measures, will be rapidly propagated and in a reasonably short time will be available for distribution to areas ascertained by the survey parties to be disease-free. These areas, it is hoped, will become centers for radial expansion of the industry.

Studies of disease and disease control have been initiated, and research will be conducted on improved methods of planting, growing, tapping, and preparing the rubber for market. Through cooperation with Central and South American governments, commercial agencies, and individuals, every possible assistance will be given to the development of a rubber-growing industry in this Hemisphere.

Foreign Agricultural Relations: This Office, through its Division of Latin American Agriculture, has directed its efforts largely to the coordination of all agencies interested in rubber production in the Western Hemisphere. The Division of Latin American Agriculture has expedited the movement of the rubber survey parties of the Bureau of Plant Industry in Central and South American countries. In close cooperation with the State Department, the Division has also promoted the cooperation of the governments of Central and South American countries in the establishment of nurseries at which rubber plants collected on the surveys are being assembled for test purposes. The Division has also worked with bureaus of the Department of Commerce that are interested in rubber, the Tariff Commission, and defense agencies. It is also making economic analyses designed to enhance the body of factual information essential to the full development of the work of this project.

SUPPLEMENTAL FUNDS

Direct Allotments

Projects	Obligated, 1940	Estimated obligations, 1941	Estimated obligations, 1942
Special Research Fund:			
Special research projects.......	$148,583	$138,800	$108,500
Special research laboratories in major agricultural regions....	339,793	330,300	330,300
Total, Special Research Fund.	488,376	469,100	438,800
Conservation and Use of Agricultural Land Resources: For making analyses of samples of superphosphate and lime........................	- -	2,780	- -
Public Works Administration, Allotment to Agriculture, 1935-1941 (B.P.I.): For flood control work on the Pecos River............................	4,416	3,084	- -
Working Funds, Agriculture (B.P.I., Advance from "1402317--Irrigation Indian Reservations, (Reimbursable)) 1940": For making soil surveys of Indian Irrigation Projects........	3,310	- -	- -
Total, Supplemental funds (direct allotments)........	496,102	474,964	438,800

PASSENGER-CARRYING VEHICLES

The work of the Bureau of Plant Industry is necessarily, to a very large extent, in the country where transportation through the use of automobiles is essential to effective work. All automobiles are used at points in the field incident to the conduct and supervision of experimental work. The authorization for the purchase of passenger-carrying vehicles for the Bureau contemplates an increase of $8,725 ($12,520 in 1941, $21,245 estimated for 1942) for this purpose. This $21,245 will permit the needed replacement of 33 cars at a net average of $580 each when exchange allowances are taken into account, and the purchase of 3 additional cars at an average cost of $700 each. These 3 additional cars are necessary for use by the Division of Fruit and Vegetable Crops and Diseases; 1 in Louisiana in connection with pecan culture and production, 1 in California in connection with fruit culture and viticultural investigations, and 1 in Florida in connection with investigations on citrus and subtropical fruits.